ELECTRICAL ENGINEERING

MAY 1944

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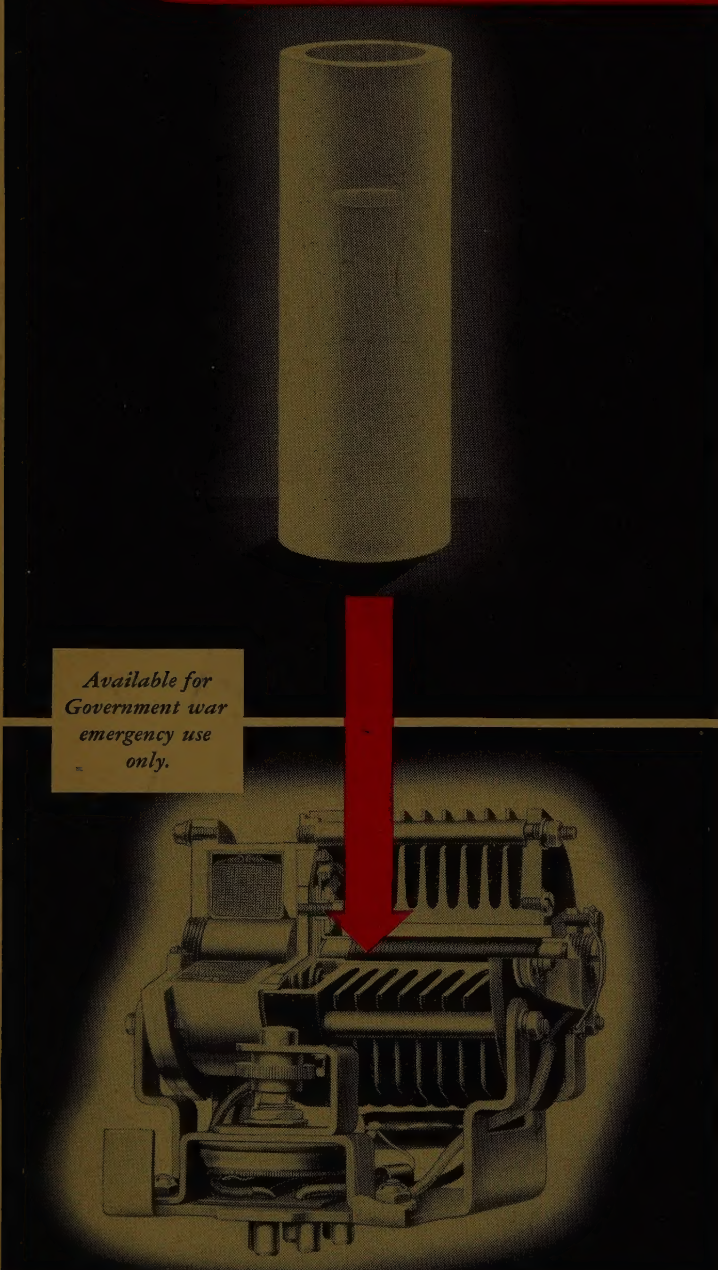
THE LITTLE GLASS TUBE THAT HELPS KEEP PLANE VOLTAGES CONSTANT...



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ELECTRICAL ENGINEERING

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MAY

1944

The Cover: Lookouts on this South Pacific transport communicate with the bridge by telephone; this is just one of numerous vital functions performed electrically on modern ships (pages 170–4).
United States Navy photo

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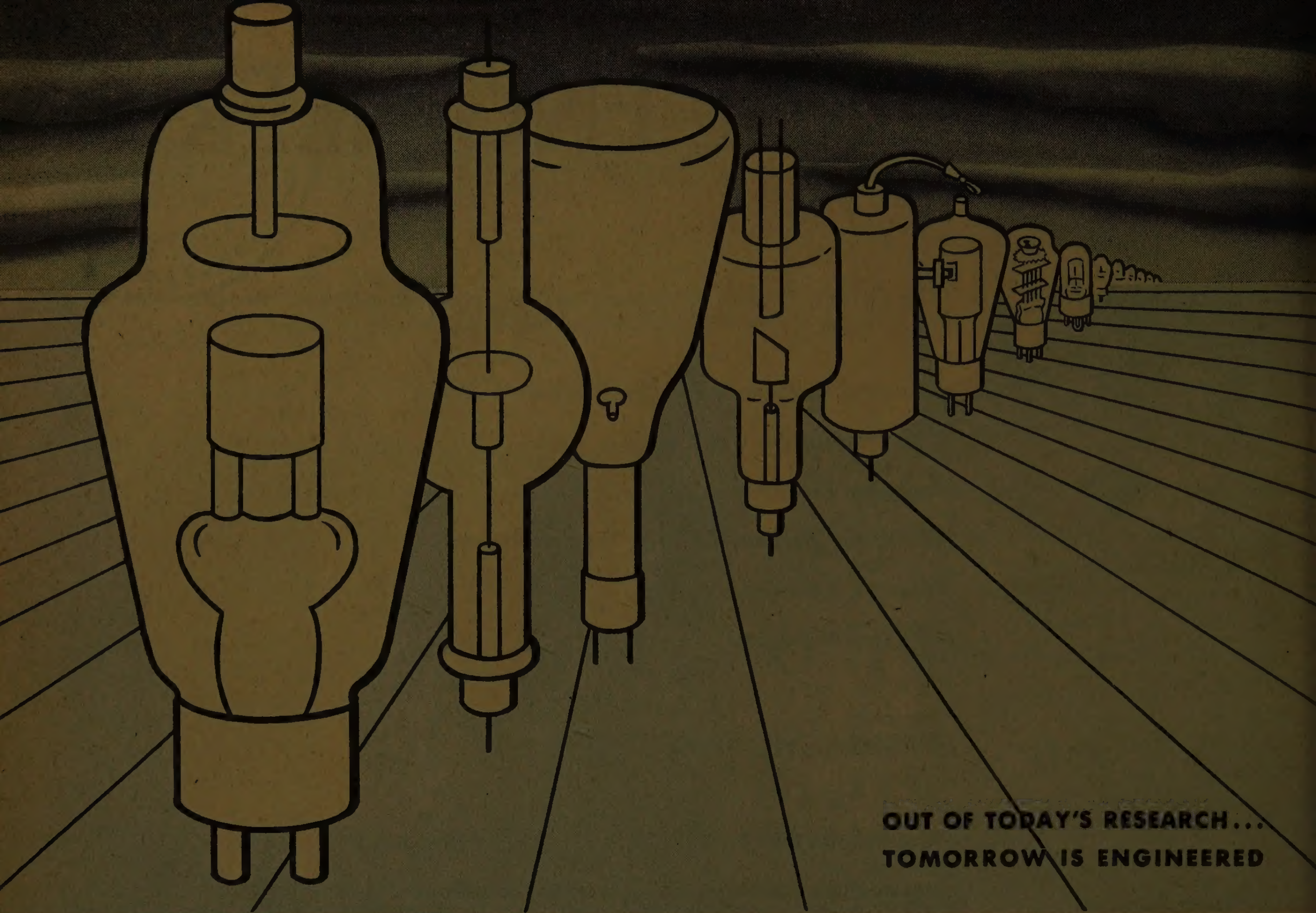

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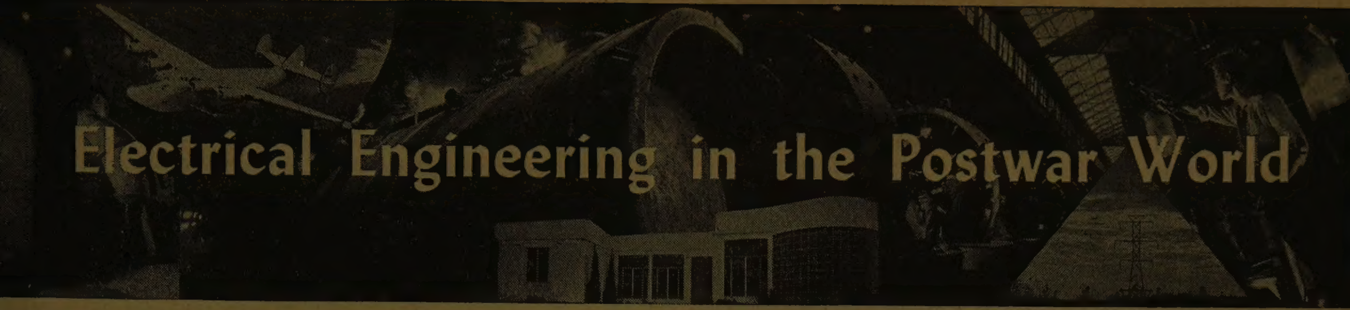


I—Influence of Wartime Developments

NEVIN E. FUNK
PRESIDENT AIEE 1943–44

Engineers have been devoting and will continue to devote first attention to winning the war—the problem that stands paramount to all others today; but as the peace to follow promises to be still more highly technological than even this war has proved to be, it is imperative that engineers have an eye to the postwar world. Likewise, "Electrical Engineering," which has been devoting and will continue to devote primary attention to war problems, now should look also to the postwar period. Therefore, a series of articles on the general topic "Electrical Engineering in the Postwar World" is being developed for serial publication. It is hoped that these articles, which are being prepared by prominent electrical engineers, will prove stimulating and thought-provoking, and that they thereby may make some contribution toward winning the peace. President Funk sounds the keynote of the series in this introductory article. Succeeding articles will cover various phases of the subject. Additional comments from readers are invited. —Editors

IT IS not the purpose of this article to deal with any specific branch of electrical engineering or science, nor to present a detailed discussion of types of improvement in equipment design, since these various fields of activity will be covered adequately by specialists in later articles in this series. Rather I wish to draw a general picture of what we may hope will happen in the future.

As we unroll the scroll of history, we find that age after age nations rose to great heights of civilization, and then declined and finally perished in the disaster of war brought on them by enemies who had not been softened by easy living, and who had developed new implements of war to give themselves greater assurance of victory. The earliest wars covered only a very small portion of the earth. However, with the development of newer means of transportation, the area involved in conflict increased in each succeeding major war. As increasingly greater forces were involved, each side, with newly acquired technical knowledge, developed mechanical implements of destruction to support the efforts of its individual soldier. These new mechanical devices were intended to give each soldier the advantage over his adversary and thus multiply the effectiveness of the fighting personnel.

In each case, after the struggle had ceased, lessons which were learned through efforts to improve the fighting mechanization were applied to the pursuits of reconstruction and the furtherance of peaceful endeavors. World transportation continued to improve both in convenience and in speed. However, instead of bringing to greater sections of the world a more intimate appreciation of each other, this improvement in transportation seems to have resulted only in broadening the area involved in the conflagration of war until today the populations of practically the entire world are at each other's throats.

In an endeavor to win in the present conflict, our science and engineering, working hand in hand with industry, have developed, produced, and put in the fighting field implements of war undreamed of a few years ago. These devices now make it possible to reach behind the fighting forces and blot out the sources of supply—in effect, to put the entire civilian population in the front-line trenches. The question of whether or not knowledge of these new developments will make the nations realize that modern warfare is so destructive that even the victor losses cannot be answered at this time. However, the application to peaceful pursuits of these many developments which were only in the embryo stage at the beginning of hostilities certainly will be accelerated after the war.

Although throughout history each succeeding war has been more mechanized than the preceding ones, the present conflict surpasses by far in every department of warfare anything that has gone before. The chief reason for this is the tremendous strides that have been made in the knowledge of science and its application in the past two decades, knowledge which could be turned immediately into the channels of fighting materials. Conversely, the intense devotion of every effort toward the production of still better weapons will have built up at the end of hostilities a vast storehouse of perfected mechanisms ready to be adapted to peaceful pursuits. It is to be expected that greater advances will be made in engineering progress at that time than have ever been seen before.

Nevin E. Funk is vice-president in charge of engineering, Philadelphia Electric Company, Philadelphia, Pa.

During the Civil War in the United States electricity played a part in military operations for the first time, and then only to a small extent in communication, since the telegraph was the only practical electric device available. However, in each succeeding war the use of electricity has increased, until now there is scarcely any device used, the satisfactory functioning and control of which does not depend in some way upon the application of electrical science. The war needs of the moment have speeded up electrical developments; when these developments are applied later to civilian uses, they will not only make material changes within the electrical industry itself, but also affect many manufacturing processes—in some cases almost to a revolutionary extent—and leave their mark on the products of most industries.

When we consider the changes taking place in electrical engineering, we must realize that practically all types of engineering science are inherently interrelated and interdependent in our present economy. Change in one is bound to reflect to a greater or less extent in some or all of the others, depending on its nature. We also must keep in mind that in our use of electricity we rely more on its manifestations in the form of light, heat, mechanical power, and chemical effects, than we do on some of its other characteristics. As an illustration of the postwar trend, a few examples of what may be expected in electrical developments after the war are cited in this article. These, however, must not be considered as in any way circumscribing the potential postwar field of electrical engineering.

Progress has been made in aviation which was undreamed of a few years ago. In this progress electrical engineering has played no small part, not only in providing greater safety in the ability to control planes, but in developing a type of communication which was only hoped for a few years ago. The new knowledge gained in these developments will not only increase materially the safety of air travel in the future, but make it less dependent upon weather conditions.

In all probability much of the equipment developed for the guidance of airplanes can be adapted to increase the safety of ships at sea. Such equipment might also be used to safeguard train operation by keeping the locomotive engineers of the future in continuous contact with the train dispatching office of the railroads. Furthermore, it is not at all impossible that we may find long-distance wire communication supplemented where required, by radio telephony.

Lighter-weight equipment for power purposes, capable of operating at frequencies ranging from 400 to 500 cycles, and lighter-weight higher-speed generators and motors have been built for use in the field of aviation. The experience and knowledge gained in this entirely new field of design in all likelihood will find their way into many civilian uses, although probably not as direct applications of the equipment as developed.

Materials can now be welded successfully which previously were not responsive to this type of operation. Entirely new electric-welding tools and automatic welding devices have been developed, which would have been very slow in making their appearance but for the tremendous mass production that came with the war. As a matter of fact, electric welding is used in the production of practically every implement of war. Because of the urgency of the present situation, welding operations have been attempted and have turned out successfully which under normal conditions probably would have been rejected at the outset as impractical.

Drying with infrared light rays had been applied successfully in a few instances previous to the war. This new development has been promoted materially by the present need for increased production and the necessity of reducing the time involved in operation. It is to be expected that after the war a radical change will be made in method by almost every industry concerned with the quick drying of paints, enamels, and varnishes. Many other applications of this type of heating probably will be made outside of this field.

An entirely new type of heating has been developed during the war, namely, electronic heating. This has been used to speed up the drying of glues used in building up the laminations of plywood. Its speed of drying and increased adhesion, compared with the old methods, are really miraculous. This type of heating is only in its infancy.

Although we had short-duration high-intensity lighting to make photographs of high-speed motion previous to the war, now even shorter-duration light of still greater intensity is available. This development permits the analytical study of very high-speed motions which previously could not be made. Its use will increase materially the basic knowledge of high-speed mechanisms of this type, as well as open up the possibility of producing entirely new designs. Along with this light for study of high speed has come high-speed X ray which will add materially to our knowledge.

We have made tremendous steps in the mass production of many items which we formerly thought could not be produced by this method. In applying these lessons later to our civilian economy, we should be able to manufacture many articles more cheaply than we previously knew how, and thus make them available to many more consumers. This unquestionably will apply to articles in popular demand as well as to the more technical types of equipment.

There undoubtedly will be some revolutionary developments in the application of plastics to the production of electrical equipment, not only as an insulating material, but in some cases replacing metal as the main framework of the device. Plastic affords a pleasing and lasting finish inherent in the material itself and has the additional desirable feature of reduced weight.

Because of the astounding results obtained from their application, electronic devices have appeared to the popular mind to be the major electrical improvements which have come out of the war effort. Although it is true that increased application of electronic devices is the most spectacular development, many far-reaching changes have been made also in the design of normal types of equipment which ultimately will result in the improvement of almost everything electrical.

There has been practically a cessation in the production of any but the most necessary equipment for civilian use. However, even though their present efforts are applied wholly to war production, the men who formerly manufactured products for civilian use cannot help but consider occasionally the possibilities of what can be done to improve their prewar products when they can start manufacturing them again. Without question their ideas have been changed by the new types of work they are now doing, and, if in the past they had gotten into a groove, these war

years will have started them along new lines of thought which are sure to bring about many new improvements.

Although it is too early to make any predictions concerning the trend that the improvements in the distribution of electric energy will take, nevertheless, I am sure that we will find application for new ideas which have been brought out in vastly different lines of endeavor. Already there seem to be some possibilities in the application of new electronic developments for relaying, remote control of switching, and telemetering. Although the work on the distribution system has been almost at a standstill, because materials were not available, and extensions and improvements necessarily were curtailed so that essential materials could be used in war work, nevertheless, many distribution engineers have been giving serious thought to what can be done when normal conditions return.

We must not overlook the fact that the present fighting personnel has been more highly trained in the handling of highly technical intricate equipment in this war than in any before. These men on coming home will enter all types of industry and will bring a fresh point of view, new ideas, and a zest for applying these ideas to normal living.

But with all the new technique we have gained, with the many almost astounding developments which have arisen, our major postwar asset still is the pioneer spirit existing in the minds of men—their firm determination to regain ground lost because of the war and to progress along the road to better living.

The Combustion Gas Turbine

F. K. FISCHER   C. A. MEYER

Engineers have been experimenting with the combustion-gas-turbine cycle for many years. Although present uses of the gas turbine are limited by the necessity of relatively high-grade fuel oils and materials that will withstand very high temperatures, research now being conducted for the war program may change the status of the gas turbine considerably in the postwar era.

THERE ARE many conceivable future uses of the gas turbine, because it potentially promises higher efficiency at very high temperatures than most engines and prime movers used today. Future applications range from electric-power generation to power plants for propelling airplanes, trains, and ships.

Advantages of the gas-turbine cycle as compared to the conventional steam system include the following: (1) no boiler is used; (2) water is not required for the simple open-cycle system; (3) it promises greater efficiency improvement at high temperature; and (4) it offers high horsepower-per-pound output for short-life applications. Factors which may retard its development include (1) the overoptimism of its potential users concerning its possibilities; (2) the necessity of using high-grade oils for fuel instead of low-grade oils and coal; (3) insufficient field experience with the gas-turbine cycle; and (4) the need for time to complete technical developments in metallurgy and component parts of the gas-turbine system. To a considerable degree, the future application of the gas turbine depends upon developments in the fields of metallurgy, aerodynamics, combustion, and heat exchange. Present knowledge in these fields permits building and operating simple gas turbines for certain purposes. Experience with some of the simple forms of gas-turbine plants has been successful and encouraging. In the postwar period, industry will benefit from the developments now being engineered for war. These developments will accelerate the application of gas-turbine plants to new and larger fields.

F. K. Fischer is steam engineer and C. A. Meyer development engineer, both with Westinghouse Electric and Manufacturing Company, South Philadelphia, Pa.

GAS TURBINE IS SIMPLE

The fundamental directness of the gas-turbine power cycle, in which all the hot gases of combustion are led straight to the turbine, has intrigued engineers for years. Versatile Leonardo da Vinci devised a crude version. In 1791, John Barber, an Englishman, took out the first patent on a turbine operated by gases. Since then there has been an almost continuous stream of developments.

Progress toward a practical gas-turbine power unit has been delayed because the thermal efficiency required to make it competitive with the highly developed steam cycle required:

1. Operation above 1,000 degrees Fahrenheit.
2. A highly efficient compressor.
3. A highly efficient turbine.

Two seemingly unrelated industries recently have made important contributions to help solve these problems. Metallurgists, in developing materials for superchargers, have produced alloys that are expected to withstand at least 1,200 degrees Fahrenheit in continuous service at the low operating pressures encountered in gas-turbine work. Aviation and wind-tunnel research on airplane wings has contributed fundamental aerodynamic data on which high-efficiency compressor designs are based. The research in these two industries plus the accumulated steam experience of many years has made possible the necessary high-efficiency turbine and compressor elements and has solved many of the mechanical problems involved in gas turbines.

In the combustion-gas-turbine system of power generation there are two basic cycles—the open cycle for moderate capacities and the closed cycle for very large units.

The open-cycle combustion gas turbine provides power directly to drive generators or machinery, since in its power cycle all the hot gases of combustion go straight to the turbine, and thus the necessity of the steam boiler, a big and expensive item, is eliminated. By contrast, in the highly developed steam cycle, the fuel energy must be converted to steam before expending its energy in the turbine.

HOW CYCLE WORKS

The combustion-gas-turbine cycle in its basic form employs the simplest power cycle known, comprising only three major elements: compressor, "combustor," and gas turbine; plus a generator or shaft for transmitting the useful power output, and a means of starting. This simple arrangement is called the open-cycle system. A general idea of the appearance and relative size of the major elements is given in Figure 1. The gas turbine resembles the straight-reaction noncondensing steam turbine. Gas-turbine blades look more like air-foil sections than reaction steam-turbine blades because of the small pressure drop and large gas volume involved. The axial-flow compressor also resembles a straight-reaction turbine, with the gas to be compressed passing axially through the compressor. The action of the blades in the axial-flow compressor is the reverse of the action of expansion in a reaction turbine. This physically small compressor handles the large volume of gas efficiently. The combustor is the burner in which

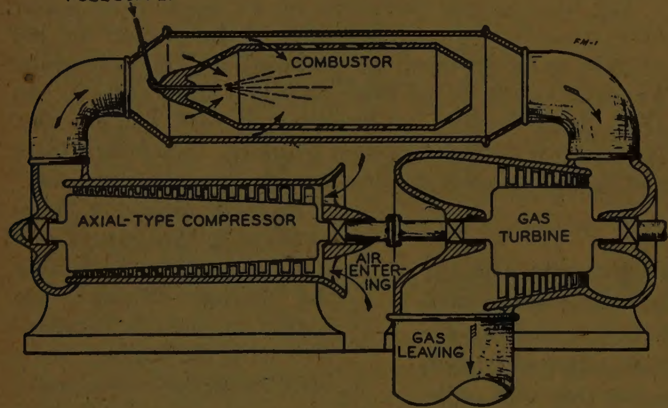


Figure 1. Elements of gas-turbine cycle are: a compressor, a combustor, and a gas turbine

the chemical energy of the fuel oil is converted into heat energy by burning the fuel with sufficient excess air to obtain the desired temperature. The hot product of combustion from the combustor is the gas, which, expanding to a lower pressure and temperature in the gas turbine, converts some of its heat energy into mechanical energy at the turbine shaft. The combustor is relatively small, since its rate of heat release is many times that of the conventional steam boiler which, in addition to burning fuel, must transfer the heat through tube walls to generate steam.

To start a combustion gas turbine some external means, such as a motor, is required, since the air for combustion is supplied to the combustor by the compressor. When the unit is in operation, the energy to drive the compressor comes from the expansion of the products of combustion in the gas turbine.

In the simple cycle operating at 1,200 degrees Fahrenheit, the products of combustion (gas) contain some 600 per cent excess air. This gas is expanded in the turbine and exhausted to the atmosphere. No intermediate fluid is used as in the steam cycle, where fuel is burned and releases chemical energy as hot products of combustion which pass through a steam boiler to generate steam for the steam turbine. The steam generator, or boiler, is the biggest single element in the steam power plant. In the gas cycle a compressor and combustor replace the boiler, and this results in a much smaller and more compact power plant. Because the simple open combustion gas cycle does not require cooling water, no steam condenser such as that used in the condensing steam cycle is needed, and plants may be located without regard to a suitable source of cooling water.

Although the first patent was taken out over 150 years ago, early inventers were unsuccessful in getting units efficient enough to drive their own compressor. The cycle was perfectly sound, but, these early inventers lacked both

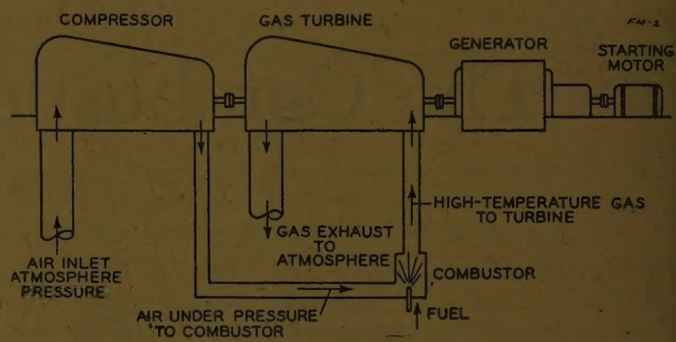


Figure 2. Simple open cycle of combustion gas turbine

materials to withstand the necessary high temperature and turbines and compressors of suitable efficiency.

HIGH-TEMPERATURE METALS DEVELOPED

Today the story is changing. Materials have been developed that are capable of operating at high temperatures. The maximum temperature employed in a gas-turbine cycle now is dependent largely on the required length of useful life of the apparatus. For a life of relatively few hours, such as might be satisfactory for some military needs, temperatures of the order of 2,000 degrees Fahrenheit are allowable. Heavy-duty long-life applications are limited to much lower temperatures. The tremendous advances made in metallurgy for the war effort, undoubtedly will produce materials capable of operation at temperatures which we would not have attained for many years under a normal peacetime development.

The combustion gas turbine requires tremendous volumes of gas. The axial-flow compressor, small in physical size, efficiently handles the large volumes required. Until recently the axial-flow compressor was to a considerable extent an unknown quantity. Today, the advancement in knowledge of proper blade shapes and research in the development of efficient air-foil sections have given the designer the necessary tools to design and build highly efficient axial-flow compressors.

TURBINE AND COMPRESSOR EFFICIENCY IS BIG FACTOR

In the gas-turbine cycle, the useful power output depends upon obtaining relatively high turbine and compressor efficiency. The useful net output is the difference be-

tween two fairly large quantities: the total turbine output and the work consumed by the compressor in compressing the air. With the system of Figure 2 operating at a top temperature of 1,200 degrees Fahrenheit, for each useful unit of power output, the turbine develops 3.95 units, of which 2.95 is needed to drive the compressor. A reduction of one per cent in the efficiency of each of these elements reduces the useful output by seven per cent. The useful output decreases sharply as the top temperature is lowered.

In Figure 3 the simple gas-cycle thermal efficiency is plotted as a function of the pressure ratio for several turbine-inlet temperatures of the combustion gas. Pressure ratio is the compressor discharge pressure divided by the compressor inlet pressure, which is 14.7 pounds per square inch absolute in the open cycle. The curves are based on these efficiencies:

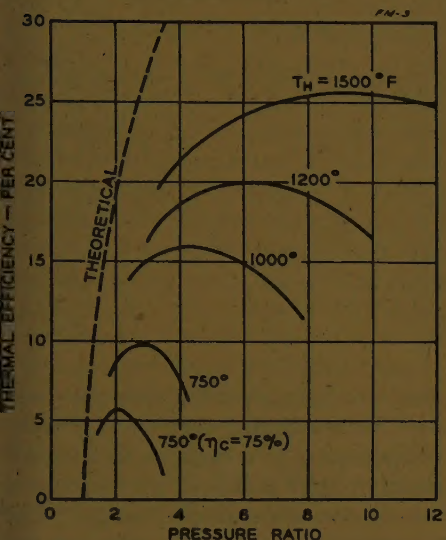


Figure 3. Effect of pressure ratio on thermal efficiency of open-cycle gas turbine without reheat, intercool, or regeneration

Assumed efficiencies: turbine 85 per cent, compressor 84 per cent, combustor 100 per cent. Air temperature 70 degrees Fahrenheit

Turbine—85 per cent.

Compressor—84 per cent.

Combustor—100 per cent.

Air-inlet temperature—70 degrees Fahrenheit.

The 750-degree-Fahrenheit curve is plotted for two different compressor efficiencies showing the effect of change in efficiency of one of the elements. A reduction in compressor efficiency of nine per cent cuts the cycle efficiency almost in half. The relatively low pressure ratios at which maximum efficiency is obtained, around 6 for 1,200 degrees Fahrenheit, means that relatively low turbine-inlet pressures exist in the open cycle, under 100 pounds per square inch absolute. Low pressure results in large gas volume and relatively large turbine-blade dimensions.

Engineers have been experimenting with this combustion-gas cycle for many years. In Europe, because of economic conditions engineers attempted to develop it as soon as materials and compressors even remotely offered a possibility of building successful units. In the United States, much of the recent development has not been described in published material because of present Government prohibition in the interest of security. However, the literature contains a considerable description of prewar applications in Europe. These plants are inferior in efficiency to what can be built today, but they apparently are giving satisfactory results. Interesting applications include a turbine locomotive, electric-generating set, compressor drive for Velox boiler, refinery drives, and airplane propulsion.

REGENERATING, INTERCOOLING, AND REHEATING AID EFFICIENCY

As shown in Figure 3 the efficiency of the simple open gas cycle is low unless extremely high temperatures are used. However, there are three practical ways of improving greatly the gas-cycle efficiency. They are: regenerating, intercooling, and reheating. The regenerating gas cycle is a cycle in which a heat exchanger (regenerator) transfers some of the heat from the relatively hot exhaust gases leaving the turbine to the air before it enters the combustor. Heating the air by exhaust gases reduces fuel consumption and improves the cycle efficiency. The amount of heat obtained from the exhaust gas depends on the size of the heat exchanger. This is an economic problem in which gain in efficiency is balanced against cost of heat-exchanger surface. Calculations indicate that the economic size of the heat exchanger will limit the regenerating cycle, at 1,200 degrees Fahrenheit inlet temperature, to approximately 75 per cent recovery of the heat available from the turbine exhaust gases. This economic size will be about 0.30 cubic foot of heat-exchanger volume per kilowatt of capacity.

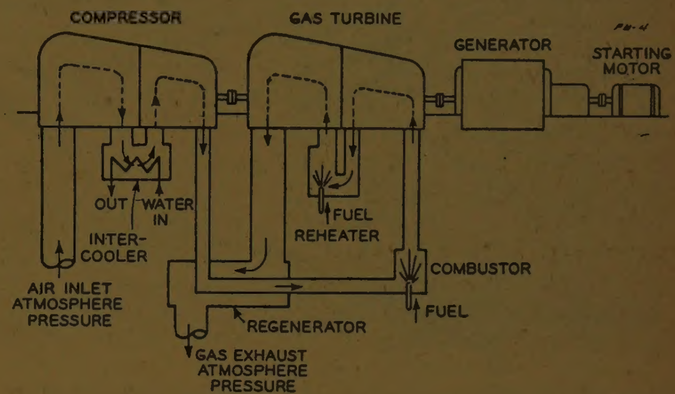


Figure 4. Intercool, reheat, and regeneration for open cycle

Efficiency is improved further when intercooling is added to regeneration. As the name implies, intercooling removes the heat of compression from the air passing through the compressor. Water, circulating through the intercooler, cools the air and is a necessary part of the cycle. By intercooling, the compressor work is reduced, because the colder air has smaller volume. Other conditions remaining the same, one stage of intercooling will reduce the compressor work by some 15 per cent. This increases the portion of the turbine capacity available as useful output and improves the cycle efficiency. A large number of intercoolers is ideal, but probably only a few stages will be practical.

Reheating, the third method of improving efficiency, consists of adding heat to the gas as it passes through the turbine. Although the gas-turbine reheat cycle employs the same principle as the reheat cycle used in many steam plants, in practice it bears little resemblance to it. Reheating in the gas turbine consists of burning fuel directly in the gas (approximately 85 per cent air) passing through the turbine. The quantity of large steam piping and con-

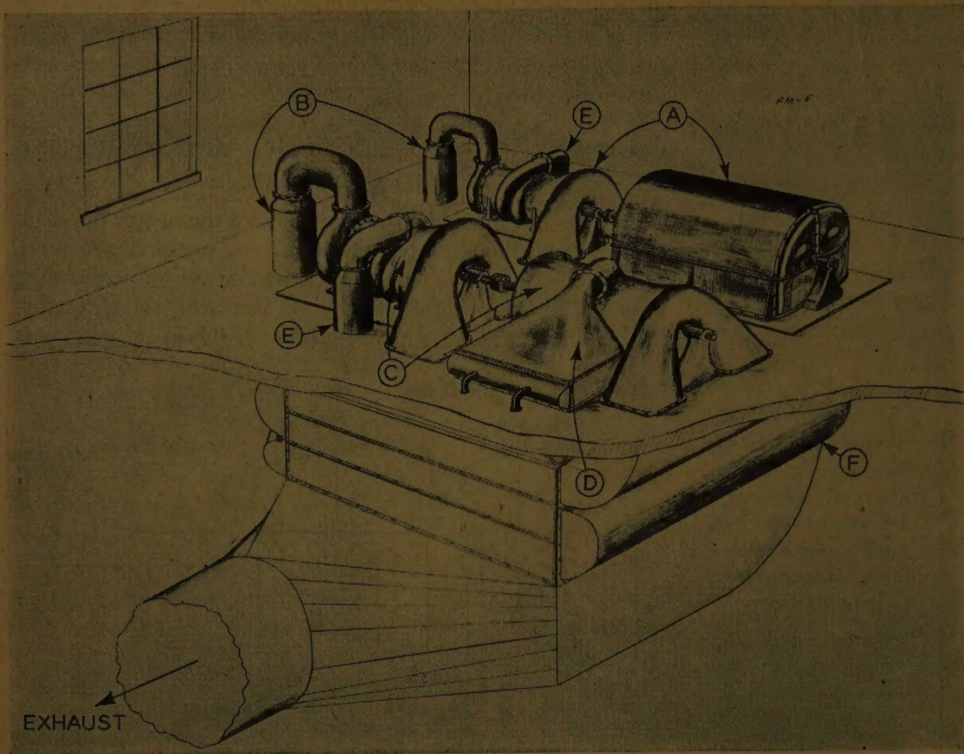


Figure 5. Artist's conception of a 5,000-kw open-cycle gas-turbine plant, using reheat, intercool, and regeneration

Two gas turbines are used: one a constant-speed generator drive, the second a variable-speed compressor drive

A—Constant-speed gas turbine and generator
B—Combustors
C—Variable-speed gas turbine and compressor
D—Intercooler
E—Reheater combustor
F—Regenerator

siderable heat-transfer surface in the heat exchanger of the steam reheat cycle is replaced by a reheating combustor which may possibly be placed inside the gas-turbine casing proper. Here again, the practical number of reheats is limited.

Reheating and intercooling increase the amount of useful energy per pound of working gas passing through the system and thus reduce the number of pounds of working medium circulated. Therefore, the size of piping and blade path in the compressor and turbine are reduced. If reheating and intercooling are used in combination with a regenerator, the terminal difference across the heat exchanger is greater for a given-size exchanger than without a regenerator, or a smaller heat exchanger transfers the same amount of heat as the larger-size exchanger. In partial-load operation the efficiency is increased by a considerable amount with this combination.

VARIOUS CYCLE COMBINATIONS COMPARED

The combination of regenerating, reheating, and intercooling is shown in Figure 4. Different cycle arrangements are compared in Table I on the basis of the power requirements of each major element, with the capacity of the generator as unity.

The thermal efficiency of the open-cycle gas turbine for various combinations of regenerating, reheating, and intercooling is shown in Figure 6. This gives the relative value of these modifications and a general idea of possible applications of this cycle. The temperature range of 1,000 to 1,500 degrees Fahrenheit was chosen, because applications at temperatures much below 1,000 degrees undoubtedly will be impractical. Early applications for heavy-duty long-life apparatus probably will not exceed temperatures of 1,200 degrees Fahrenheit with 1,500 degrees Fahrenheit and higher limits awaiting future developments in metallurgy.

The temperature of the inlet air to the compressor has a marked effect on the cycle efficiency. In contrast to steam plants, the colder this inlet air the higher the cycle efficiency and capacity. In the simple open cycle, changing the inlet air temperature ten degrees Fahrenheit changes the cycle efficiency 0.74 point or approximately three per cent per ten degrees Fahrenheit change. The effect on capacity is approximately four per cent per ten degrees Fahrenheit change. The effect on cycle thermal efficiency of inlet air temperature, on the different cycle

Table I. Effect of Different Open-Cycle Arrangements on Each Major Element

Item	Simple Cycle	Cycle With Regeneration	Intercool and Regeneration	Reheat and Regeneration	Intercool, Reheat, Regeneration
Input in fuel	4.95	3.75	3.43	3.55	3.11
Turbine rating	3.95	2.95	2.80	2.88	2.55
Compressor power	2.95	1.95	1.80	1.88	1.55
Useful output	1.00	1.00	1.00	1.00	1.00
Per cent efficiency at 1,200 F	20.2	26.6	29.2	28.1	32.2
Gas temperature in degrees Fahrenheit at:					
Turbine inlet	1,200	1,200	1,200	1,200	1,200
Leaving reheater				1,200	1,200
Turbine exhaust	635	790	695	920	865
Leaving regenerator		450	350	560	520
Air temperature in degrees Fahrenheit at:					
Compressor inlet	70	70	70	70	70
Leaving intercooler			70		
Leaving compressor	490	340	230	440	405
Entering combustor	490	680	575	800	750
Pressure (pounds per square inch absolute) at:					
Compressor inlet	14.7	14.7	14.7	14.7	14.7
Compressor discharge	88.2	51.5	73.5	73.5	102.9
Turbine inlet	88.2	50.2	71.7	71.7	100.4
Turbine exhaust	14.7	15.1	15.1	15.1	15.1

arrangements with a top temperature of 1,200 degrees Fahrenheit, is plotted in Figure 7.

STEAM AND COMBUSTION-GAS CYCLES COMPARED

Because steam is the most widely used medium for transferring heat into mechanical energy, a comparison of the steam cycle and the gas cycle may help in judging the gas cycle and its possibilities. In judging the efficiency of

power cycles, a 100 per cent thermal efficiency is not obtainable, as the temperature of the cold body is far above the absolute zero of temperature. The Carnot cycle is a theoretically perfect cycle, and no other cycle operating between the same hot and cold body temperatures can have a thermal efficiency better than it. The best any cycle can hope to do, when operating under the same conditions as the Carnot cycle, is to attain the Carnot-cycle efficiency. The gas-turbine cycle theoretically can give the same efficiency as the Carnot cycle, but this is possible only theoretically, since it requires 100 per cent efficiency of the gas turbine and compressor, and infinite number of stages of intercooling and reheating, and a regenerator infinite in size.

GAS CYCLE HOLDS BEST PROMISE

The steam cycle theoretically offers the Carnot-cycle efficiency only up to the critical pressure (705.4 degrees Fahrenheit; 3,206 pounds per square inch absolute). Above this temperature, the gap between the steam cycle and the ideal cycle gradually widens as the temperature is increased. Therefore, from a purely theoretical standpoint the combustion-gas-turbine cycle holds forth greater promise of efficiency than the steam cycle.

Of more value than theoretical efficiencies are the thermal efficiencies obtainable in practical applications. Figure 8 compares the best efficiencies obtained in large central power plants (projected to 2,000 degrees Fahrenheit) with the expected practical limit in efficiency of the large-capacity closed-cycle combustion-gas-turbine power plants. Above, 1,000 degrees Fahrenheit the gas-cycle efficiency increases approximately three times as fast as the steam-cycle efficiency for a given top temperature increase.

Table II. Comparison of Combustion Gas Turbine and Steam Turbine

5,000-Kw Rating—3,600 Rpm

Item	Open-Cycle Gas Turbine			Steam Turbine—3 Stages Feed-Water Heating
	Simple Cycle, Single Cylinder	One Reheat, One Intercool, and Regeneration: High-Pressure Turbine	One Reheat, One Intercool, and Regeneration: Low-Pressure Turbine	Single Cylinder
Inlet pressure—pounds per square inch absolute	88.2	100.4	39.4	465
Inlet temperature—degrees Fahrenheit total temperature	1,200	1,200	1,200	825
Exhaust pressure—pounds per square inch absolute	14.7	39.4	15.1	3/4
Steam or gas rate—pounds per kilowatt-hour	102	56		10.5
Full load flow—pounds per hour	510,000	280,000		52,500
Inlet volume flow—cubic feet per second	990	475		24.8
Exhaust volume flow—cubic feet per second	3,900		3,250	6,120
Ratio of exhaust volume ÷ inlet volume	3.95	6.85		250
Turbine floor area—square feet	160	150	155	100
Net generator output—kilowatts	5,000	5,000		5,000
Approximate plant thermal efficiency—per cent	18.4*	29.4*		23.6

* Inlet air temperature 70 F.

This curve compares the best modern large central steam power plants with the best practical efficiencies expected of the combustion-gas-turbine power plants. It is expected that the gas-turbine-cycle efficiency will not be affected greatly by unit size, and this combustion-gas-cycle curve can also be interpreted as applying to open-cycle gas-turbine power plants of relatively small capacity. Economic steam plants for capacities around 5,000 kw seldom exceed 25 per cent over-all thermal efficiency. This would indicate a considerable efficiency advantage, in small units, in favor of the gas cycle, provided economics permits designing it for anywhere near its maximum possible efficiency.

Figure 6. Effect of reheat, intercool, and regeneration on thermal efficiency over range 1,000 to 1,500 degrees Fahrenheit

Based on 70 degrees Fahrenheit and 5 per cent pressure drop in regenerator. Assumed efficiencies: turbine 85 per cent; compressor 84 per cent; combustor 100 per cent

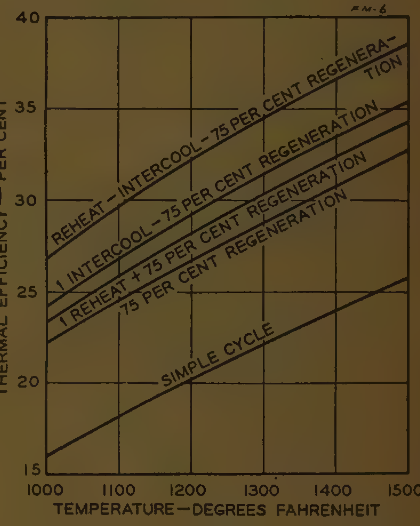
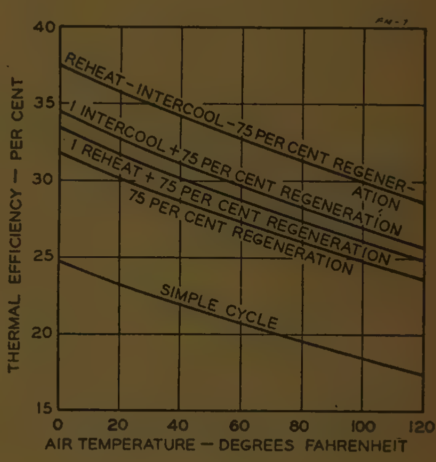


Table II, which compares a 3,600-rpm 5,000-kw steam turbine with a 3,600-rpm 5,000-kw net-output open-cycle gas turbine, shows the low pressure in the open-cycle gas turbine as contrasted to the high pressure in the steam cycle. The energy per pound of gas is small, and the flow of gas is very large: 510,000 pounds per hour for the simple-cycle gas turbine as compared to 52,500 pounds per hour of steam to the steam turbine. The large flow and low pressure to the inlet of the gas turbine gives a large volume flow which means that the piping and blading of the gas-turbine inlet are large compared to that of the steam turbine.

Figure 7. Effect of air temperature on thermal efficiency of open-cycle gas turbine with 1,200 degrees Fahrenheit inlet gas temperature

Efficiencies, air temperature, and regenerator pressure drop same as in Figure 6



The ratio of exhaust to inlet volume is small for the gas turbine. This makes a balanced blade path unlike that of the steam turbine, which in this case must handle an exhaust volume 250 times as great as the inlet volume. The large blade dimensions limit the maximum net-output rating of the open-cycle single-flow combustion gas turbine to approximately 7,500 kw. However, the injection of liquids offers a theoretical possibility which extends this limit considerably.

CLOSED CYCLE FOR LARGE UNITS

The closed cycle offers a method of increasing the maximum capacity of the open cycle. The volume of the working gas is inversely proportional to the absolute pressure. If the pressure is multiplied by 10, the size is divided by 10. In the closed cycle, the circulating working gas is at a relatively high pressure and reduces the physical size of compressor and turbine. To reduce the temperature of the gases before they enter the compressor, cooling water is required in the closed cycle. The heat exchanger in which the gas is cooled before it enters the compressor is called a gas precooler. The amount of heat given up to the cooling water is equivalent to that removed in the condenser of a steam unit of equal capacity. The quantity of cooling water required will be less in the gas unit than in the steam unit, as a higher water temperature rise is permissible in the gas unit.

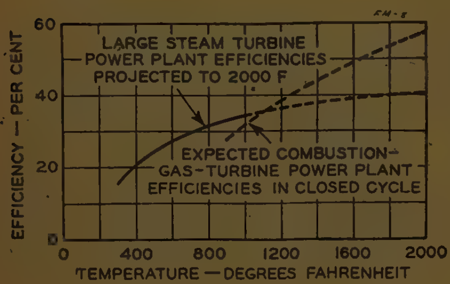


Figure 8. Efficiencies compared for best practical steam power plants and combustion-gas-turbine plants

The closed cycle in Figure 9 is the one used by Escher Wyss, a Swiss firm who claim that it has an efficiency equal to that of an up-to-date steam plant.[4] This is an externally fired cycle in which the products of combustion do not pass through the gas turbine and compressor. The working gas (air, hydrogen, or other medium) operates at a relatively high pressure in a closed recirculating circuit. In the gas heater, the heat from the products of combustion is transferred to the working gas which then expands in the turbine to a lower pressure. The gas heater in this cycle corresponds to the steam boiler in the steam cycle. For a practical efficiency, it will be larger than the modern steam boiler, because gases are on both sides of the gas heater. This cycle is very similar to the steam cycle, except that the working fluid does not undergo a change of state. As this closed cycle keeps the products of combustion out of the turbine and compressor circuit, the problem of using coal as a fuel should be much simpler of solution than in those cycles which circulate the products of combustion.

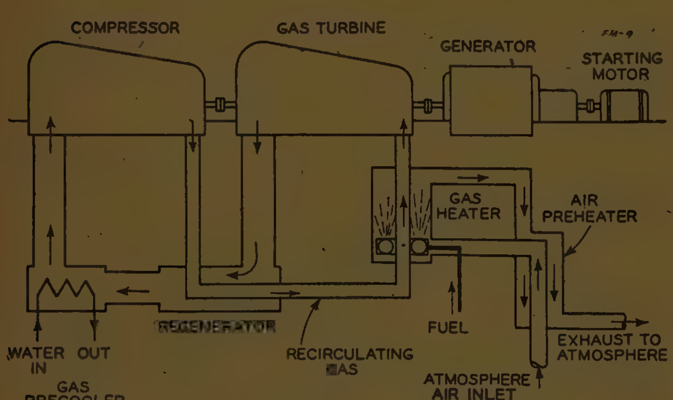


Figure 9. Escher Wyss externally fired closed cycle

HYDROGEN HAS ADVANTAGES

In the closed cycle, the compressor inlet pressure will be maintained at approximately 150 pounds per square inch with a discharge pressure of some 600 pounds per square inch. This high pressure greatly reduces the size of turbine and compressor and should permit maximum ratings to be built approaching those in the steam cycle. Some gas other than air may be used as the working medium in the externally fired closed cycle. Hydrogen, for example, has properties which make it far superior to air for this application. The density of hydrogen is $1/_{14}$ that of air, the specific heat is 14 times that of air, and the thermal conductivity is 6.8 times that of air.

NEW CYCLE STUDIED

A closed-cycle system under development by Westinghouse Electric and Manufacturing Company is shown in Figure 10. In this closed cycle a separate gas turbine and compressor are used to pump up the cycle on which the main gas turbine and compressor operate. High pressure of around 600 pounds per square inch may be used with a compressor inlet pressure of around 150 pounds per square inch. The main gas turbine and compressor would be small as they operate at high pressure. This cycle is fired internally, the products of combustion passing through the gas turbines and main compressor. A compressor driven by a second gas turbine supplies enough make-up air to maintain pressure and support combustion. This closed cycle eliminates the necessity of the large gas heater required by the Escher Wyss cycle, but requires an extra gas turbine and compressor to pump up the system. Solid matter from the fuel must be removed.

In the closed cycles shown in Figures 9 and 10, reheating and intercooling are not illustrated. However, they offer the same advantage in the closed cycle that they offer in the open cycle. The biggest single additional problem in the closed cycle is a method of building practical heat exchangers. The problem is complicated further by the fact that the gases will carry foreign matter from combustion which may both corrode and erode the exchanger and reduce the heat-transfer rate by depositing foreign material on the transfer surface.

GAS-TURBINE CONTROL

Combustion-gas-turbine control can be simple and reliable, consisting only of regulating the gas temperature by controlling the rate of fuel supply. Governing valves, such as those used in steam-turbine control, are not needed. Efficient partial-load performance can be obtained by using two turbines: one variable-speed turbine driving a compressor; plus a constant-speed turbine driving a generator. The use of regenerators, reheaters, and intercoolers, in addition to improving the full-load economy, has an even greater effect in improving the partial-load economy. In the closed cycle, by reducing the gas pressure as the load is reduced, practically full-load efficiency can be maintained at partial loads.

POSSIBLE GAS-TURBINE APPLICATIONS

The possible applications of the gas turbine are many. Ranging from a simple open cycle for small capacities to

a closed cycle for very large ratings it offers wide possibilities. For example:

Locomotives. The simple open gas cycle requires no water. It has low weight and small space requirements combined with simplicity. With an efficiency of 20 per cent at 1,200 degrees Fahrenheit and the expected low maintenance of turbine drives, it should prove a good power plant for a locomotive. The inability of the gas turbine to operate in reverse makes either electric drive or the development of a satisfactory reversing gear necessary for this application.

Airplanes. For relatively small power outputs, such as required by the airplane industry, the gas turbine operating at high speed and high temperature to obtain maximum rating per unit weight of material has real possibilities.

Ship Drives. The combustion gas cycle offers efficiencies equal to the best modern marine steam power plants, which have over-all efficiencies of approximately 25 per cent. Weight and space requirements of equipment are a real factor in the marine application. The gas cycle eliminates the steam generator and steam condenser. The advantage in weight and space undoubtedly will favor the gas cycle, despite the fact that it includes gas compressor, the regenerator heat exchanger, and the large gas turbine. The requirement of astern operation in marine service handicaps the gas turbine, except as an electric drive.

Power. General application of the combustion-gas cycle in the power-generation field probably will not occur until the problems in connection with the use of coal as a fuel are solved. The successful development of the closed cycle is necessary if units of very large capacity are to be built. The maximum capacity for which units can be built in the open cycle will include the majority of industrial applications. There are many special applications in the power-generation field in which the open gas cycle possibly will find early application. Examples are emergency standby service and low-first-cost units on the ends of transmission lines. In these a simple open gas cycle offers may advantages, such as no water required, low first cost, simplicity, small space requirements, and practically automatic operation with few attendants.

Processing. In the industrial field, where both power and process steam are required, the gas turbine has possibilities. It fits well in those applications where the steam required is relatively small in relation to the power load. This is different from the extraction steam turbine where large quantities of process steam per kilowatt are necessary to attain a comparably efficient cycle. Here again, the use of coal as a fuel is necessary for a wide general application.

MANY PROBLEMS AHEAD

In drawing conclusions, it should be remembered that the cycle has only had practical application in very special cases. The full possibilities of any cycle can only be evaluated from successful proof of its economy, first cost, maintenance cost, and reliability. The addition of elements which improve the fuel economy and arrangements of the cycle for large capacities are obtained at a sacrifice in simplicity and at a price. The development of the best system is expected to be costly in time and money.

Metallurgy plays an important part in the gas cycle as the efficiency increases rapidly with increase in top temperature. To obtain materials suitable for operation at higher temperatures the metallurgists are looking at materials similar to the nonforgeable and nonmachinable tool steels. The method of forming these alloys to shape, such as precision casting to size, may revolutionize accepted methods of manufacture. In order to apply such materials, their additional first cost and manufacturing cost must be justified. Any application of such materials must be preceded by careful tests. For heavy-duty apparatus these tests must extend over long periods before the designer can use them with safety. Careful differentiation between applications as to required length of life of apparatus is necessary. The fact that a piece of equipment is operated at 1,800 degrees Fahrenheit for a life of a few hours does not mean that temperatures of that order can be used for heavy-duty applications.

Present developments of the gas turbine are limited to the use of relatively high-grade fuel oils. This one factor is a serious handicap to the gas cycle. There is considerable evidence that oil is being used at a greater rate than new supplies are being found. So in the postwar period necessity may dictate a prime mover which can use coal as a fuel. The gas cycle is definitely limited in application until such time as the problems in connection with the burning of low-grade oil and coal are solved successfully.

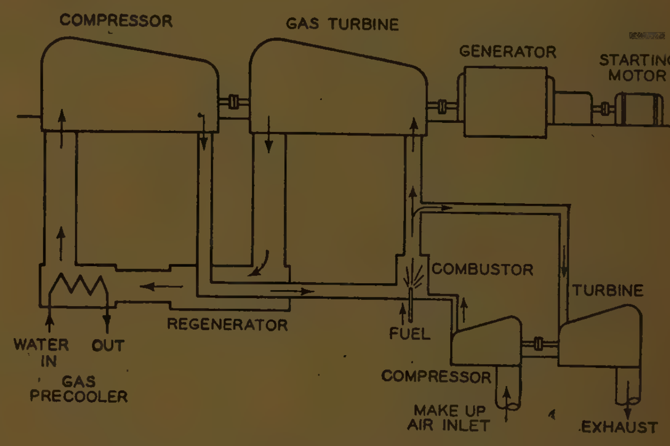


Figure 10. Proposed internally fired closed cycle

Present research efforts are being expended in developments for the war program. In the postwar era industry will have access to the developments in the gas-turbine field and to developments in high-temperature materials. These developments may change considerably present thinking. It is safe to predict that general applications of the gas cycle must wait until the postwar era.

It will be wise to watch the developments of the early installations before attempting to make widespread applications. At present, conclusions as to the ultimate possibilities of the gas cycle are little more than good guesses. The gas-turbine art must advance beyond its present early development stages, before it can be judged with assurance. However, undoubtedly it will find real usefulness in a large number of fields, possibly complementing rather than competing with the steam turbine. Just how and where the gas turbine will be applied, only time will tell.

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Seagoing Electricity

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This article presents a composite picture of the electrical installation on a typical modern peacetime turbine-propelled cargo vessel. The power, lighting, and interior-communication systems are described in detail.

THE COMPLETE electric system of a modern peacetime cargo vessel must comply with the rules of the United States Coast Guard Merchant Marine Inspection Service (formerly the Bureau of Marine Inspection and Navigation), the American Bureau of Shipping, AIEE Standard 45, and Senate Report 184. It also must meet the requirements of the United States Public Health Service in regard to ratproofing. The typical modern cargo vessel described in this article is a hypothetical turbine-propelled vessel of about 450 feet in length and 9,500 tons deadweight.

In order to show clearly the size and diversity of such an electric installation, it is considered here under the three headings generally used throughout the shipbuilding industry: namely, power, lighting, and interior communication. The technical details of equipment are not described, as the principles involved are generally the same as for similar shore equipment. However, all equipment is marine type, suitable for the conditions of roll and pitch, vibration, moisture, and corrosion encountered on shipboard.

POWER

The power system includes all generators, switchboards, motors, controllers, and wiring therefor, except for certain minor motor generators, motors, and switchboards which are integral parts of other systems. Figure 2 shows an elementary one-line diagram of the power system.

There are three 200-kw 120/240-volt three-wire d-c turbine-driven main generators, any two of which will carry the full ship's load. (Diesel-propelled vessels have Diesel-driven generators.) As the rules of the regulatory bodies prescribe a standby generator of a size equal to the largest installed, it is more economical to provide several small generators, rather than one large one, to carry the ship's load, as this reduces the size of the standby generator needed. These generators are flat compound wound and must operate in parallel.

The main switchboard, Figure 3, consists of a generator panel for each generator and panels as necessary for the distribution of power to power-distribution panels, lighting-distribution panels, various separately supplied motors, and so forth. Group control panels are provided for distribution of power to and control of the engine-room auxiliaries. (In some cases the engine-room auxiliaries are fed directly from the main switchboard, and the control panels are located adjacent to the motors.)

A 15-kw 120/240-volt three-wire d-c emergency Diesel-electric generator and switchboard are installed in the superstructure to supply power for emergency lighting, certain of the vital auxiliaries, some interior-communication systems, and interior-communication battery charging, and, through a double-throw switch to provide a feedback to the main switchboard for deadship starting.

Under normal conditions the emergency switchboard is supplied from the main switchboard. Upon failure of or a reduction of 20 per cent in the voltage from the main power plant, the emergency Diesel-electric unit starts automatically and, upon coming up to voltage, is connected automatically to the emergency switchboard by means of an automatic transfer switch which also disconnects the feed from the main switchboard. Upon restoration of voltage on the main switchboard, the transfer switch disconnects the emergency generator and reconnects the feed from the main switchboard.

Duplicate motor alternators are provided for the supply of 115-volt 60-cycle alternating current where required for various interior-communication systems.

Motors are 230 volts direct current, marine type, and, in general, are stabilized shunt wound. They are of open, dripproof, or enclosed waterproof type as required by their location. Motors for engine room and boiler room are designed for operation in an ambient temperature of 50 degrees centigrade and motors elsewhere for operation at 40 degrees centigrade. Pump motors and ventilation motors have 25 per cent speed reduction, and forced-draft-fan motors 60 per cent. Windlass and warping winch motors are compound wound, and cargo-winch motors are stabilized series wound. Steering-gear motors are shunt wound, constant speed. There are about 110 motors installed, varying in size from one-sixth to 65 horsepower.

Controllers for auxiliaries are of the magnetic type for large sizes, and manual across-the-line type for the smaller sizes, four horsepower 230 volts and two horsepower 115 volts and under, where automatic operation is not required. These starters are divided further into two types, low-voltage protection and low-voltage release. Upon failure of voltage, the low-voltage-protection controllers drop out and must be restarted manually, while the low-voltage release type automatically will restart the motor upon restoration of voltage. The low-voltage release type generally is used for vital auxiliaries. The use of the low-voltage-protection type for nonvital auxiliaries decreases the load on the generator when the power supply is restored after failure.

Warping winch and windlass controllers are full-magnetic reversing type. Cargo-winch controllers are full-magnetic reversing dynamic-lowering type. A recent

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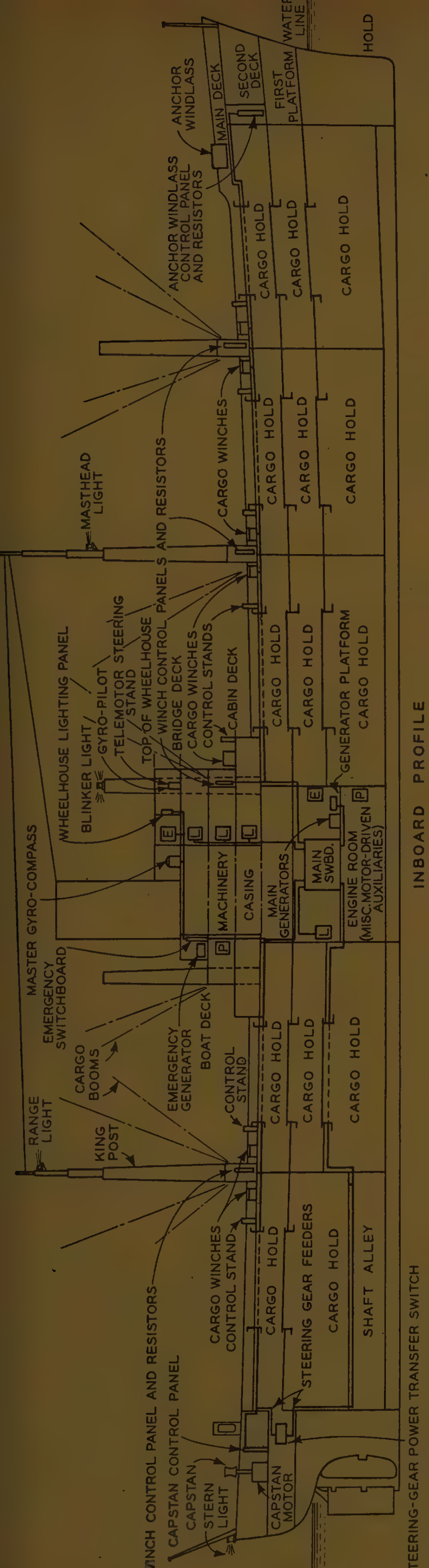

Figure 1. Side elevation showing approximate location of electric equipment on a typical merchant vessel

One-quarter inch equals 12 feet approximately
L—Lighting-distribution panel
E—Emergency lighting-distribution panel (fed from emergency switchboard)
P—Power-distribution panel

Also in wheelhouse:
Engine-order telegraph
Shaft-revolution indicator
Echo-sounding indicator
Whistle control
General-alarm contact maker
Smoke-detecting cabinet
Telephones
Voice tubes
Call-bell push button
Rudder-angle indicator

development is the use of the unit-type cargo winch, which has all the equipment except the master control stand, mounted in one enclosure and on one base or foundation.

The forced-draft fans are interlocked with a solenoid valve in the fuel-oil line to the boilers, so that no oil can be supplied to the boilers unless the forced-draft fans are operating. This is done to prevent boiler explosions.

LIGHTING

General requirements specify that the vessel shall be lighted adequately throughout with standard marine fixtures of a design particularly adapted for the location in which they are placed. Minimum illumination values are in accordance with the contract specifications. (When these values are not given in contract specifications, they should be in accordance with AIEE Standard 45.) Fixtures are divided into two general classes, watertight and nonwatertight. Watertight fixtures are used in locations exposed to considerable moisture, such as engine rooms, deck lockers, galley, refrigerated spaces, and outside spaces. Cargo holds are provided with a special heavily guarded watertight fixture. Living spaces are furnished with nonwatertight fixtures. Since different types of mountings are required, the fixtures also are divided into two further classes, bulkhead fixtures and ceiling fixtures. Mirror lights, with convenience outlet, are installed over mirrors in toilets and staterooms. There are berth lights for each berth, and desk lights for all desks.

Switches are watertight or nonwatertight in conformity with the fixtures as previously described and are single pole. Where spaces have two or more entrances, three-way or four-way switches are used, so that the lights may be controlled from any entrance. Switches for refrigerated spaces are located outside the doors and equipped with pilot lights.

Convenience receptacles, watertight or nonwatertight as required by the location, are provided where needed throughout the vessel.

General lighting-distribution panels are fed from the main switchboard, are 115/230 volts three-wire direct current, and are of the door-in-door type. Switches in these panels are of the circuit-breaker thermal-overload-trip type rated at 30 amperes, 115 volts. One spare switch is installed for each eight switches or fraction thereof.

All lighting circuits beyond the distribution panels are 115 volts, two wire. Ceiling lights and bracket lights are on separate circuits. Bracket fans and convenience receptacles are on separate circuits from the lights.

Floodlights are provided for illumination of the deck and hatches while the crew is working cargo, and boat-launching floodlights for the illumination of lifeboats while these are being loaded and lowered over the side. The boat-launching floodlights are connected to the emergency lighting system and controlled by switches in the wheelhouse.

Loads on lighting branch circuits are limited to 880 watts (1,120 watts for the duration of the emergency). Motors larger than one-quarter horsepower or other devices consuming more than 660 watts (1,320 watts for the duration of the emergency) must not be connected to lighting circuits.

Emergency lighting is installed as required in passageways, engine rooms, and so forth, in order to furnish

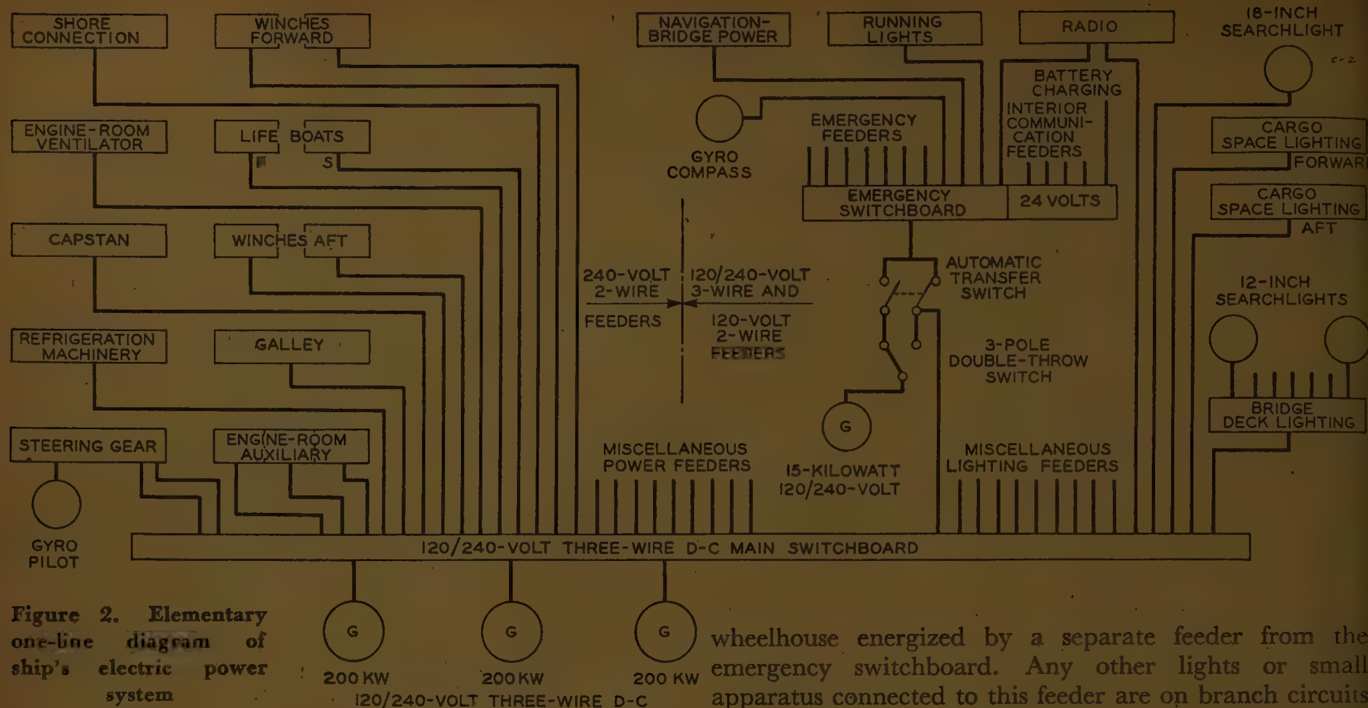

Figure 2. Elementary one-line diagram of ship's electric power system

sufficient illumination for emergency escape, or emergency repairs. Receptacles connected to the emergency system are located in the engine room and engineer's workshop. Emergency lighting circuits are fed from separate distribution panels connected to the emergency switchboard. There are no switches on these circuits except in the distribution panels.

The running lights consist of two side lights, masthead light, range light, stern light, anchor lights, towing lights, and not-under-command lights. Masthead, range, stern, and side lights are of the double-filament type and are connected to the telltale panel. Anchor, towing, and not-under-command lights are single filament and are connected to receptacles on the emergency lighting system. (These lights also may be connected to the telltale panel if desired.)

Running lights are controlled by a telltale panel in the wheelhouse energized by a separate feeder from the emergency switchboard. Any other lights or small apparatus connected to this feeder are on branch circuits protected by fuses of not over three-ampere capacity. The telltale panel indicates, both visually and audibly, the failure of a lamp. When one switches over to the reserve lamp or filament, the audible and visual signals are reset.

All-around blinker lights are located on the king posts and connected to the emergency lighting system. These lights are controlled by telegraph keys in the wheelhouse and on each bridge wing.

A separate feeder from the main switchboard is used for the 18-inch searchlight. This searchlight is of the pilot-house control type and is fitted with a switch in the wheelhouse. The two 12-inch signaling searchlights are supplied from the bridge-deck lighting panel.

Figure 3. Main switchboard—dead-front type

INTERIOR COMMUNICATION

Interior communication includes all signal, alarm, indicating, and radio systems—in fact, everything electric which is not included under power and lighting. A list and brief description of these systems follows:

Radio. The radio system consists of a main transmitter covering the intermediate-frequency channels, a high-frequency transmitter, an emergency transmitter (combined with the main transmitter), a high-frequency receiver, a low- and intermediate-frequency receiver, an emergency receiver, an auto alarm, a radio direction finder, all necessary batteries, battery chargers, generator, and antennas. This installation must meet the requirements of and be approved by the Federal Communications Commission. Two 230-volt d-c sources of power are provided, one from the main switchboard and one from the emergency switchboard. A recent development is the use of console or unit-type equipment, in which all possible parts are mounted in one housing.

Gyro-Compass System. This system comprises a master gyro compass and repeaters located throughout the vessel as required for navigation. The power supply is from the 230-volt bus on the emergency switchboard.

Gyro-Pilot System. The gyro pilot is of the two-unit type providing an electric telemotor system which parallels

the ship's hydraulic telemotor system and affords automatic steering of the vessel. Power is supplied from the steering-gear feeders and is 230 volts direct current.

Echo-Sounding System. The echo-sounding system is used for determining the depth of water. It consists of a supersonic transmitter and receiver installed in the bottom of the vessel, an indicator which gives the depth of water directly, and a recorder. The indicator is mounted in the wheelhouse and the recorder in the chartroom. Power supply is 115 volts direct current from a power panel to the motor alternator supplied with the equipment.

Whistle Control. The whistle is equipped with both mechanical and electric control. The mechanical control consists of mechanical pulls located in the wheelhouse and on each bridge wing. The electric control consists of contact makers located in the wheelhouse and on each bridge wing, a timing contactor, and a solenoid-operated valve at the whistle. The "at-will" signal, when made from any of the three electric controls, will discontinue the "automatic" signal until the "automatic" signal is restored from the wheelhouse. Automatic signaling is used during fog and, by means of the timing contactor, may be set for five-second blasts at intervals of 1, $1^1/_2$, or 2 minutes. The emergency switchboard supplies 115 volt d-c power.

General Alarm System. The function of this system is to warn the crew in an emergency. It consists of a contact maker located in the wheelhouse, and eight-inch gongs located so as to be audible in all sleeping, working, and recreational spaces. Fused branch boxes, located above the bulkhead deck are furnished for each gong. This system is supplied from duplicate 24-volt interior-communication batteries located in the battery room.

Smoke-Detecting System. This system consists of pipes running to all cargo holds and other spaces to be protected, through which a constant current of air and thus any smoke are drawn. The appearance of smoke in the detecting cabinet can be seen and also will sound an alarm. The power for this system is 115 volts direct current from the emergency switchboard.

Sound-Powered Telephones. Two sound-powered magneto-ringing common-talking telephone systems are provided, a deck system and an engineer's system. The deck system includes telephones in the wheelhouse, captain's quarters, steering-gear room, emergency steering station, bow, and radio room. The engineer's system affords communication among the wheelhouse, engine room, chief engineer's quarters, emergency generator room, and steering-gear room. All stations on a system are intercommunicating.

Figure 4. 200-watt watertight lighting fixture for engine room

Figure 5. Watertight bulkhead fixture for general use

Figure 6. 200-watt watertight lighting fixture for cargo holds

Figure 7. Non-watertight lighting fixture for quarters

Voice Tubes. Voice tubes are installed for communication between the gyro-compass room and the wheelhouse magnetic compass, the wheelhouse and radio room, and the wheelhouse magnetic compass and the standard compass on the housetop.

Call-Bell System. All passenger staterooms, officer's staterooms, wheelhouse, radio room, and similar spaces are equipped with push buttons connected to an annunciator and bell in the pantry or galley. The power for this system is from the duplicate 24-volt interior-communication batteries.

Refrigerated-Spaces Alarm System. All refrigerated spaces having doors which can be so locked from the outside that they cannot be opened from within have push buttons connected to an annunciator and bell in the galley to provide an alarm in the case of personnel being locked in these spaces. The current for this system is obtained from the 24-volt interior-communication batteries.

Engine-Order Telegraph. The engine-order telegraph system consists of transmitters with reply equipment in the wheelhouse, on the wheelhouse top, and on each bridge wing; an indicator with reply equipment located at the engine control station; and one indicator without reply equipment at the boiler control station. This system may be of either the mechanical or the self-synchronous electric type. If self-synchronous, the power is obtained from the common interior-communication motor alternators.

Shaft-Revolution Indicator. The shaft-revolution indicator is of the magneto type, with the magneto connected to the shaft and with indicators in the wheelhouse and at the engine control station. The magneto has a mechanical revolution counter and the indicators have electrical counters. The wheelhouse indicator also has dial illumination with a dimmer rheostat. Current for the dial illumination and the electrical counter is obtained from a 115-volt lighting circuit.

Rudder-Angle Indicator. A self-synchronous rudder-angle indicator is equipped with a transmitter at the rudderhead and an indicator in the wheelhouse. The wheelhouse indicator has dial illumination, with dimmer, connected to a lighting circuit. The a-c supply is from the common interior-communication motor alternators.

Electric Pyrometer. On steam vessels an electric pyrometer is connected to a thermocouple at the gas outlet of each boiler and to a selector switch. On Diesel vessels the thermocouples are installed in the exhaust from each cylinder and the common manifold, for the main engine, and in the common exhaust manifold for the auxiliary engines. Where the auxiliary engines are of sufficient size, thermocouples also are provided for each cylinder. The pyrometers are of the high-resistance direct-reading type with automatic cold-junction compensation.

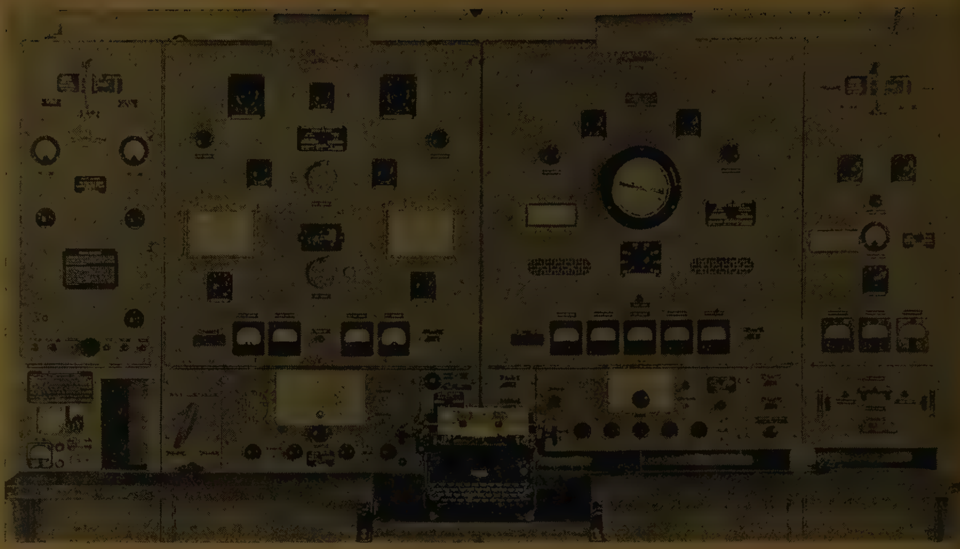

Figure 8. Console-type radio equipment

Lubricating-Oil Alarm. The lubricating-oil alarm consists of a horn actuated from pressure switches located below the lubricating-oil gravity tanks. This system is supervised and is energized from the 115-volt bus in the engine-room emergency lighting panel.

Fuel-Oil-Filling Alarm System. Unless furnished with a common standpipe system, each fuel-oil and settling tank is equipped with an alarm to indicate when the tank is practically full. On a common standpipe system, the alarm is provided only for the settling tanks. Current for this system is obtained from the 115-volt lighting system.

Salinity-Indicator System. This system indicates the amount of solids in the feed water and gives an alarm when the concentration at any cell exceeds the alarm setting. Cells are located as required by the feed-water system. Power is obtained from the motor alternators. (A similar system is used for evaporator plants when installed.)

DEAD-SHIP STARTING

As a matter of interest, the procedure for dead-ship starting is as follows:

1. Start emergency generator, energize emergency lighting in engine room, and otherwise clear the emergency switchboard as far as possible.

2. Clear main switchboard, except for fuel-oil service pump, forced-draft fans, and necessary engine-room lighting. (If boilers do not contain sufficient water, the feed-water pump may be energized.)

3. Close feed-back switch on emergency switchboard.

4. Start forced-draft fans and fuel-oil service pump.

5. When sufficient steam is available, start one main generator and connect to switchboard when voltage is normal; at the same time open the circuit breaker to the emergency switchboard. The emergency generator and the main ship's service generator are not operated in parallel.

6. The loads on the main switchboard then can be energized up to the capacity of one generator. The second generator is started and the remainder of the load connected to the main switchboard.

7. The emergency generator then is stopped, the feed-back switch thrown to the normal position, and the emergency-switchboard circuit breaker on the main switchboard closed.

Figure 9. Gyro-pilot steering stand

CONCLUSION

Because of the present war emergency, none of the special electrical features have been included in the description of this installation. These special features require some modifications and additions to the systems mentioned and also increase the load on the ship's generators. Although the ship described in this article does not include all equipment and systems that may be and are installed on various cargo vessels, it is sufficiently typical to enable a reader unfamiliar with merchant craft to obtain a general idea of the electrical installation on such a vessel.

Electronic Devices Aid Metallurgical Research

E. V. POTTER

Electronic devices found useful in metallurgical research in the fields of ore dressing, hydrometallurgy, pyrometallurgy, and physical metallurgy are reviewed in this article. Use of these instruments for temperature measurement and control, length and displacement measurements, and magnetic testing, and in induction furnaces and chemical and spectrographic analyses is discussed.

ELECTRONIC apparatus and equipment using elec tronic circuits in their operation cycle are so numerous in metallurgical work that any attempt to discuss each application, even briefly, is not possible in any article of reasonable length. Without attempting to cover the field completely, the following list of general applications will give some idea of their extent:

1. High-voltage low-current rectifiers for use with electrostatic separators, X-ray diffraction units, and electrostatic precipitation equipment.

2. Low-voltage high-current rectifiers to replace motor generator sets in electrolytic processes.

3. Electron microscopes.

4. X-ray tubes for both hard and soft radiation for radiography and diffraction work, respectively.

5. Phototubes for applications such as colorimeters for chemical analyses, densitometers for spectrographic and X-ray measurements, color analyses, and smoke detectors.

6. Cathode-ray tubes for use as oscillographs and visual detectors for making numerous measurements.

7. Stroboscopes for observing the behavior of structures and materials under dynamic conditions.

8. Furnace controllers using vacuum tubes and phototubes, and many other applications using combinations of various types of electronic circuits and devices to perform special operations.

This article is concerned primarily with the applications which have been found useful in metallurgical research in the fields of ore dressing, hydrometallurgy, pyrometallurgy, electrometallurgy, and physical metallurgy. The first four fields do not lend themselves to such diverse applications as does the field of physical metallurgy, but such apparatus as electrostatic separators, automatic furnace controllers, induction furnaces, rectifiers, microscopes, and X-ray diffraction units are used widely and involve electronic devices. Also in the associated chemical work, titrimeters, conductivity bridges, colorimeters, pH meters, and polarigraphs employing electron tubes find extensive applications. Many of these pieces of equipment need no discussion, because they have been described many times, and their operation is well known. Therefore, the more special and unusual applications, especially in the field of physical metallurgy will be the only ones discussed in this article.

TEMPERATURE MEASUREMENT AND CONTROL

Probably the most important factor in metallurgical research is the measurement and control of temperature, and the range to be covered is very wide. In work involving temperature differentials, differences in the order of 0.1 to 50 degrees centigrade are encountered, while in other work a range of 0 to 1,200 degrees centigrade is quite common. Direct measurements of these temperatures can be made readily by resistance thermometers or thermocouples, but a form of self-balancing photoelectric potentiometer has been found very convenient for these measurements, because it requires no manipulation and can be used for recording the temperatures on oscillographs, recording milliammeters, or any type of recording mechanism not requiring more than ten milliamperes of current to energize it.

A potentiometer substantially the same as the one now in use was described by R. W. Gilbert[1] in 1936; it is available commercially from several manufacturers. The circuit diagram for this instrument is shown in Figure 1. It consists of two phototubes V_1 and V_2, a high-amplification-factor triode V_3, two voltage regulators V_4 and V_5, a damping circuit R_2 and C_1, a protecting resistor R_1, standard resistor R_s, output current instrument M_1, galvanometer G, lamp L, and prism P. The principal of operation is to vary the current through the standard resistor R_s so that the potential drop across the potential terminals of R_s balances the potential e applied across the input terminals. When this condition is true

$$e=i_sR_s$$

and the output current i_s is proportional to the unknown voltage e applied to the input terminals. Without elaborating on the theory of operation, i_s can be said to vary with the plate current i_p of tube V_3, which is determined by the potential of the grid of V_3 relative to its cathode. Under typical operating conditions, the currents might have values of i_3 = 3 milliamperes, i_p = 3 to 13 milliamperes, and i_s = 0 to 10 milliamperes.

The automatic operation is obtained by connecting the galvanometer G in series with the unknown potential e and resistor R_s. The light from lamp L is reflected from the mirror of the galvanometer to the prism P, where it is split into two beams, one going to each of the phototubes V_1 and V_2. Then, if the galvanometer has the proper polarity, any unbalance between the input voltage e and the potential drop across R_s will cause the galvanometer to deflect, changing the relative amounts of light on V_1 and V_2 and thereby changing the grid potential and plate current of V_3, until the voltage i_sR_s is nearly sufficient to balance the potential e. If the galvanometer G had no restoring force, the value i_sR_s would equal exactly e, but, when the suspension exerts some torque, enough current must flow through the galva-

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nometer to maintain the deflection required to shift the light beam enough to maintain the currents i_p and i_s. Thus, we have an instrument which automatically will maintain a current i_s nearly proportional to the unknown potential e, and the value of e can be read directly on an instrument M_1, the calibration factor depending on the value of R_s. Also, any recording device, operating on less than ten milliamperes, can be connected to the output terminals, and a permanent record of the changes in potential e can be made. In addition to its versatility, this potentiometer can be used even when the polarity of the potential e reverses. When e is zero, i_p is equal to three milliamperes, and so reversal of the polarity of e will reduce i_p to a lower value, reversing the direction of i_s and again balancing i_sR_s and e. The sensitivity in this direction is decreased, however, and the range of i_s is limited to a maximum value of three milliamperes as compared to ten milliamperes in the opposite direction.

In actual operation, one of these instruments required a galvanometer deflection of one millimeter at meter distance to shift the current i_s from zero to ten milliamperes. The galvanometer sensitivity was 1.4×10^{-6} volt, showing that between zero and the maximum current of ten milliamperes the potential drop across the galvanometer changed by 1.4×10^{-6} volt. If the mechanical zero of the galvanometer corresponded to $i_s=0$, this absolute value of 1.4×10^{-6} volt would be the difference between the value of e and the product i_sR_s corresponding to a maximum current of $i_s=10$ milliamperes. If the mechanical zero corresponds to other values of i_s, then the drop in potential across the galvanometer may be more or less than this value. In any case, the potential drop and error will not exceed 5×10^{-6} volt, which is as close as measurements ordinarily can be made with the usual types of potentiometers. Actually, in any potential range exceeding 0 to 0.5 millivolt full scale, this error is less than one per cent, and thus the instrument M_1 or the recording mechanism will limit the accuracy of the measurement.

Potentiometers of this type can be made to have ranges as low as ten microvolts and as high as ten volts full scale. Thus, with chromel–alumel thermocouples, temperature differences as low as 0.025 degree centigrade can be measured readily, and the range from 0 to 1,200 degrees centigrade is very readily and accurately measured. A typical laboratory-model instrument is seen in the upper left-hand corner of Figure 2.

The accurate control and regulation of furnace temperatures are very important in all metallurgical processes and research, and a wide variety of instruments have been developed to maintain constant temperatures or to vary temperatures automatically according to a predetermined time schedule. These instruments generally make use of the expansion of metals, generation of an electromotive force by a thermocouple, or the change in resistance of an electric conductor to actuate the controlling mechanism. All these actuating methods can be used with electronic devices, but electron tubes are most generally used in conjunction with thermocouples or resistance thermometers. Several of these controllers will be described.

A very common type of controller uses a thermocouple, a millivoltmeter with a metal vane mounted on the pointer, and a vacuum-tube oscillator. The tuning and feed-back coils of the oscillator are arranged so that the vane moves between them, and the change in the oscillator plate current from the oscillating to nonoscillating condition or the change in plate current with change in frequency is used to actuate a relay and regulate the power to the furnace.

A typical circuit diagram is shown in Figure 3. The oscillator circuit is arranged so that the coupling between L_1 and L_2 prevents the circuit from oscillating when the vane is not between the coils. At low temperatures the plate current through M_1 is high and the heat is turned on. As soon as the vane enters the space between coils L_1 and L_2 and the coupling between L_1 and L_2 is decreased sufficiently, the tube will start to oscillate; this causes the plate current through M_1 to decrease suddenly, opening the relay and turning off the power. Another arrangement is to have the tube normally oscillating with a low plate current, so that the oscillations cease when the vane reduces the coupling between L_1 and L_2; the sudden increases in plate current operates a relay which turns off the power. Still another variation on this general type is to let the vane on the millimeter needle change the frequency of the oscillator, the change in plate current associated with the change in frequency being used to activate the power relay.

The potentiometer type of controller is very accurate and has found very wide use. The electromotive force of a thermocouple is balanced against the voltage drop in an adjustable slide-wire resistor, any difference between the two potentials being used to activate the control mechanism. These controllers can be subdivided into two groups, one in which a galvanometer is used to detect the unbalance between the potentials and to activate the controls, and one in which the unbalanced potential itself is used to activate the controls. The first group includes instruments mechanically activated by the galvanometer as well as those in which a light beam reflected from the galvanometer mirror activates the controller. The first type will not be discussed in this article, because no new electrical devices are involved.

A typical diagram of the second type is shown in Figure 4. When no light is shining on the phototube, the grid bias on the vacuum tube is sufficiently negative to prevent any appreciable flow of plate current through the relay. When the galvanometer deflects enough to reflect the light beam onto the phototube, the grid bias becomes more positive, and the plate current in the vacuum tube increases suddenly to 15 milliamperes or more, activating the relay. The light beam is in the form of a rectangle, about 2 millimeters wide and 15 millimeters high, and a

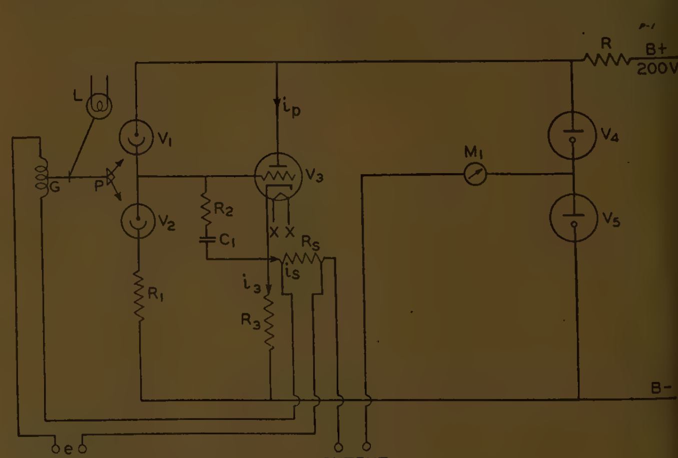


Figure 1. Photoelectric potentiometer

Figure 2. Thermoanalysis apparatus

shield over the phototube provides a sharp edge so that a motion of the galvanometer sufficient to shift the beam less than its width will cause the relay to open or close. This type of controller is sufficiently sensitive to operate in a temperature range of one degree centigrade. One of these instruments is seen on the left-hand side of Figure 2.

It is evident that the self-balancing photoelectric potentiometer previously described could be used as a controller just as well as the photoelectric type shown in Figure 4. However, it is not so sensitive as the other type, because, in order to produce a sufficient change in current to get positive relay action, the input voltage would have to change a proportionate amount. This would correspond to a rather large change in the thermocouple temperature and certainly would not be comparable to the one-degree-centigrade range of the type just discussed.

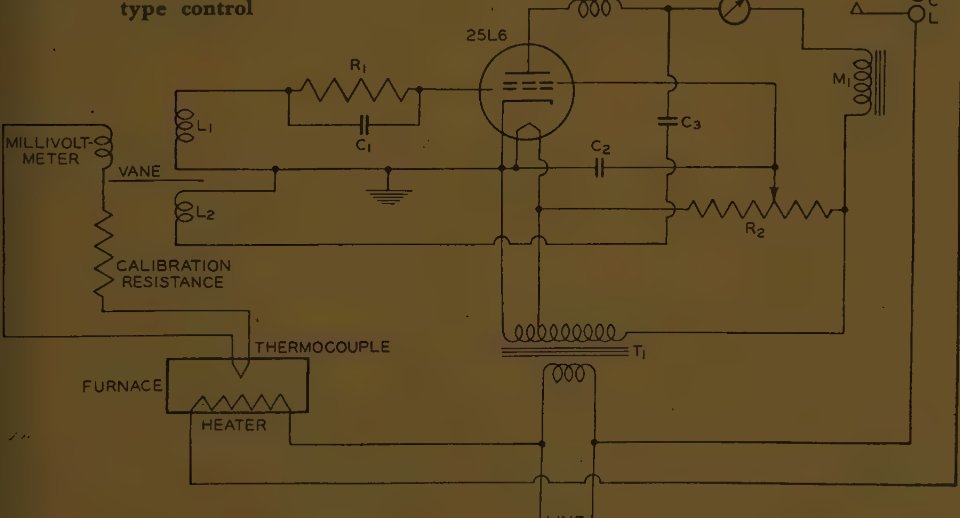
There are two controllers which use the unbalance in voltage between the thermocouple and a potentiometer to actuate the controls without a galvanometer. One of these types is shown in Figure 5. The d-c unbalance potential between the thermocouple and the potentiometer is converted to an a-c voltage by means of a carbon microphone alternately compressed and released at 60 cycles per second. The converted voltage is fed through a step-up transformer to the voltage amplifier and then to the grids of two thyratrons. Depending on the polarity of the d-c unbalance voltage, one thyratron or the other will fire and activate a relay to turn the heating power on or off.

Another type accomplishes the same result by using a 60-cycle operated vibrator to apply the unbalance voltage alternately to one of two windings on a transformer. An a-c voltage is produced in the secondary winding, which after amplification can be used to activate two thyratrons as in the circuit just discussed.

Another type of controller uses the variation in resistance of a resistance thermometer to operate the control circuit. The thermometer is one arm of a Wheatstone bridge, the bridge being in balance at the desired temperature. Any deviation of the temperature from this value will unbalance the bridge, producing a potential across the detector junctions of the bridge. This potential is amplified and used to excite the grids of two thyratrons as in the controllers just described. Unbalance in one direction will cause one thyratron to conduct plate current while unbalance in the other direction will cause the other thyratron to conduct plate current and operate a relay.

Each of the three types of controllers just discussed can be used also for recording temperatures. In the first two the relays are replaced by a motor which rotates the slide on the potentiometer slide wire so as to restore balance. A pen attached to the slide arm then can be used to record the temperature. In the Wheatstone-bridge type the motor would be used to vary a resistor in the bridge circuit and restore balance; a pen attached to the resistor or motor would record the temperature.

Figure 3. Vacuum-tube oscillator-type control



Another arrangement used as a temperature recorder employs a bridge composed of two resistors and one fixed and one variable capacitor. The unbalanced bridge potential is amplified and applied to two thyratrons which drive a motor attached to the shaft of the variable capacitor. The motor varies the capacitance to restore balance in the bridge; a recording pen on the capacitor shaft will record the temperature.

All the instruments described so far have been for use in recording or measuring temperatures or maintaining temperatures at fixed values. With

little change they can be readily adapted for operation on predetermined time–temperature schedules. With the controllers using milliammeters to activate the controller circuits, it is only necessary to couple the arm, carrying the oscillator coils to a shaft, activated by a motor-driven cam. The cam can be cut to produce any desired motion of the arm in the milliammeter, and thus the controller will operate to maintain the furnace temperature at a value determined by the cut of the cam.

In the potentiometer-type controller a similar cam arrangement can be made to rotate the slide on the potentiometer slide wire, varying the voltage to correspond to the desired temperature. With the resistance-type controller, one arm of the bridge circuit can be varied so that balance would occur at the desired temperature. The conversion to operation with variable temperatures is largely mechanical and warrants no further discussion in this paper.

Applications of Temperature Measuring, Controlling, and Recording Devices. Apparatus of the type just described can be used to determine important properties of metals, alloys, and clay minerals. For example, one of the important constants of a metal or alloy is the temperatures at which changes in its crystalline structure occur. Proper heat treatment to obtain the desired properties in a metal or alloy require that these critical points be known accurately, and apparatus for determining these temperatures is very important. This can be done as follows:

A specimen of an unknown steel, for example, is placed inside a hollow metal cylinder made of a material which has no transition points in the temperature range to be studied. Thermocouples then are placed in the cylinder wall and in the specimen and connected differentially, so that any difference between the temperature of the cylinder and the specimen can be measured. As the specimen and containing cylinder are heated, the differential will be small and essentially constant until a transition point is reached, at which point the specimen will either absorb or give off heat increasing or decreasing the temperature differential. Thus, in order to determine the temperature at which this transition occurs, the differential couples and the couple in the cylinder can be connected to self-balancing potentiometers which are connected to a dual recorder, and the temperature corresponding to peaks in the temperature differential curve can be readily found. The temperature of the specimen and holder should be increased at an essentially uniform rate for best results, and this is done by using a controller of any of the types described fitted with a cam mechanism for increasing the temperature of the balance point at the desired heating rate.

A very similar application is the thermal analysis of clay minerals. These analyses have been found to be quite useful for differentiating between clays which have very similar crystalline and optical properties and for analyzing clay mixtures which are not too complex. The apparatus for making these determinations is shown in Figure 2. The clays are placed in a metal crucible in a pot furnace (center of Figure 2) and heated at a uniform rate by means of a photoelectric-type temperature controller (left of Figure 2), the temperature differential between the clay and its container being measured on a photoelectric potentiometer (upper right in Figure 2). Each clay will have transitions at temperatures which are characteristic of that material; it can be identified by the magnitude of the differential peak and the temperature at which it occurs. In the case of mixtures, the clays composing it can be identified individually from the composite differential curve, and the relative amounts of each type present can be estimated from the area under the differential peaks.

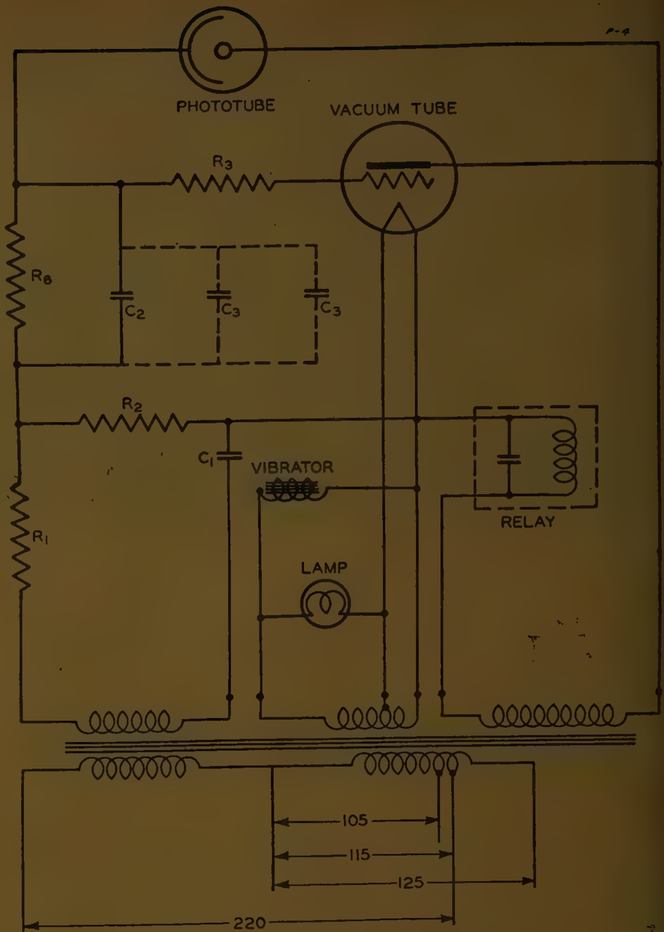


Figure 4. Photoelectric-type control

LENGTH AND DISPLACEMENT MEASUREMENTS

The afore-mentioned applications of electronic equipment involved temperature phenomena only, and such applications are limited in number. However, several types of instruments suitable for length or displacement measurements have been developed which increase the field of application tremendously. The measurement

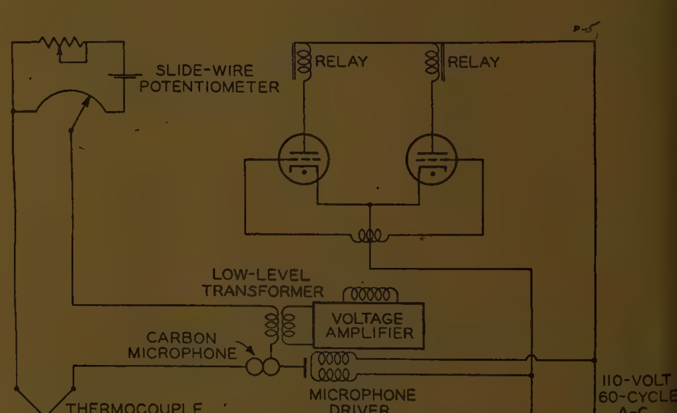


Figure 5. Potentiometer-type control

of absolute length is necessary in many cases, but this can be accomplished quite well by normal methods which need not be discussed. The measurement of changes in length and displacements, both static and dynamic lend themselves readily to electronic methods. These applications will now be discussed.

In dealing with metals, an obvious method for measuring changes in length or displacements is to use the change in electrostatic capacitance between the specimen and a metal plate, caused by the motion of the specimen relative to the plate. This method is fundamentally sound, but a number of difficulties are encountered when the usual methods are used for converting these capacitance changes into electric currents or voltages for recording or measuring. Depending on the type of converter circuit used, difficulties are encountered in obtaining sufficient sensitivity, eliminating interference from local electrostatic fields, and in operation over wide frequency bands.

The Bureau of Mines has been using a circuit which eliminates these difficulties to a great extent. The basic circuit diagram of this converter is shown in Figure 6, and a complete description of it and its operation will be found in a previous publication.[2] It consists of two oscillators, A and B, very well-isolated and shielded from each other, and a coupling circuit by means of which energy can be transferred from one oscillator to another. The oscillators, which are of the ordinary tickler feed-back type, operate at a frequency of approximately 1,000 kilocycles. The coupling circuit consists of two coils L_1 and L_2 closely coupled to the oscillator tuning coils, a rectifier tube V_1 and a d-c milliammeter M_1. The rectified direct current is indicated on M_1, and the stray capacitance in V_1 and M_1 (C_1) serves as a path for the high-frequency current.

These oscillators operate very much like two a-c generators in parallel. If both are tuned to exactly the same frequency, and the couplings between the oscillators and the coupling circuit are equal, no current will flow in M_1. If the normal frequency of either oscillator is changed slightly by a change in its tuning capacitance, energy will be transferred from one oscillator to the other in order to keep them synchronized, and current will flow through M_1. Thus, over a considerable range of capacitance above and below the value corresponding to identical normal frequencies for the two oscillators, they will continue to oscillate at the same frequency and the current in M_1 will vary approximately in proportion to the deviation of the capacitance from its normal value.

The variation of current with tuning capacitance is shown in Figure 7. The current rises rapidly on either side of a minimum value, and for values of capacitance below or above the limits shown the oscillators will not remain synchronized, and the current will drop suddenly. The minimum current is not zero, as it theoretically could be, because the oscillator circuits and their coupling to the synchronizing circuit are not identical, and some unbalance is always present. It can be seen, however, that the portion of the curve on the high-capacitance side of the minimum current point is essentially a straight line for a wide range in current and capacitance values. By operating in this range, we can obtain a current which is proportional to capacitance. In studying any phenomenon which can be reduced to a capacitance change, it is necessary only to connect this changing capacitance in parallel with one of the oscillator-tuning capacitors, and the current in M_1 will change in proportion to the changes in capacitance.

With this unit, current ranges from 5 to 50 milliamperes can be obtained with a sensitivity of two milliamperes per micromicrofarad with the normal synchronizing circuit and 1.5 milliamperes per micromicrofarad with the 1,000-ohm resistor in the synchronizing circuit. This unit has several important advantages:

1. The shape of the current–capacitance curves and the sensitivity can be controlled readily.
2. The unit is simple to operate.
3. It will respond to changes in capacitance having frequencies from zero to several hundred kilocycles per second.
4. It has low background voltage, the internal noise being approximately 0.003 volt across 1,000 ohms.
5. It is free from interference by local magnetic and electrostatic fields, so long as their frequencies differ appreciably from the resonant frequency of the oscillator circuits.

This instrument in conjunction with the temperature-operated instruments previously discussed has been very useful for making dilatometric, damping-capacity, and modulus measurements.

Applications. Dilatometric measurements are very important in metallurgical research, because they provide a means of studying phase changes in alloy systems as well as of measuring the coefficients of expansion of solid materials. The usual dilatometer consists of a quartz tube closed at its lower end and suspended from a metal base. The specimen to be tested is placed in the bottom of the tube, and a quartz rod is placed so as to rest on the upper end of the specimen. When the outer quartz tube is heated or cooled, the change in length of the specimen causes the inner rod to move relative to the outer tube. An ordinary dial gauge clamped to the outer tube can be used to measure the motion of the inner rod, but for recording the motion it has been found convenient to change this motion into a proportional change

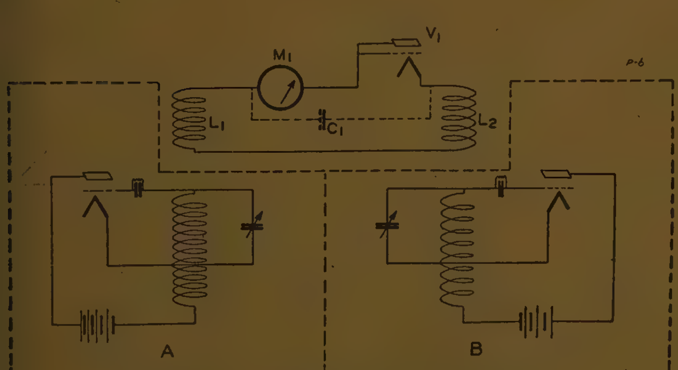


Figure 6. Coupled-oscillator transducer

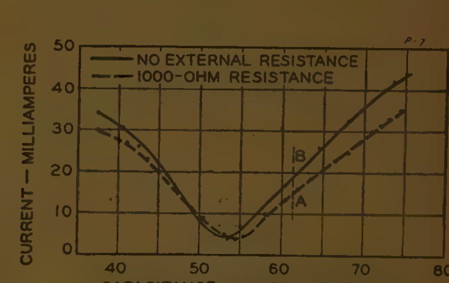


Figure 7. Synchronizing current—capacitance curves

in electric current. This can be done by fastening metal plates to the two quartz tubes and using the change in capacitance between the plates as the inner rod moves to change the current from the converter circuit just described.

A better arrangement, however, is to use two electric strain gauges in a bridge circuit. This arrangement is shown in Figure 8. The strain gauges G_1 and G_2 are cemented on opposite sides of a small strip of plastic material about one-eighth-inch thick, and the strip is fastened to base B at one end and rests on the inner quartz rod Q_2 at the other end. Thus, motion of the rod Q_2 will bend the strip P, compressing one gauge and stretching the other. The two gauges are the resistors R_1 and R_2 in the bridge circuit in Figure 9. Thus, the expansion of the specimen will unbalance the bridge and change the voltage d across the detector terminals of the bridge; and, for small changes in the ratio of R_1 to R_2, the voltage d will be proportional to the change in the values of R_1 and R_2, which are in turn proportional to the displacement of the end of strip P.

Either an alternating or a direct potential can be used across the bridge arms at e. If alternating current is used, the unbalance voltage d can be amplified and measured as alternating current or rectified and measured as direct current. As a direct current, it can be used readily to record the expansion of the specimen. If a direct potential is used, the d-c potential across d can be applied to a self-balancing potentiometer and recorded along with the temperature of the specimen.

By far the most useful application of the electrostatic converter circuit is in the measurement of damping capacity and modulus. Before discussing the technical details, however, it would be better to explain just what is meant by the term "damping capacity."[3]

The phenomena associated with damping capacity are well known in spite of the fact that few are familiar with that term. For example, we say that a piece of lead is dead, meaning that if it is dropped or if a bar of it is struck the only sound it gives off is a dull thud. On the other hand, a piece of steel or brass will emit a sound of very definite pitch if it is dropped or struck. This difference in behavior is caused by the fact that the energy imparted to the lead when it strikes the floor, or is struck, is rapidly dissipated as heat and the vibrations are damped out too quickly for the ear to recognize any definite pitch in the emitted sound. The steel or brass, on the other hand, absorbs the energy at a much lower rate, and the vibrations in the body will continue long enough for the ear to recognize that the sound has a definite frequency. The rate at which vibrational energy in a body is converted into heat is a characteristic of the material, and it is this property we are referring to when we speak of damping capacity.

Quantitatively, damping capacity can be expressed in a number of ways, but the term "specific damping capacity" is the only one we will discuss here. This term is defined as the ratio of the energy lost in a body as heat, when it is subjected to a cycle of stress, to the potential energy stored in the body at maximum stress, and it is usually expressed in per cent. On this basis, lead will have a "specific damping capacity" of 10 to 20 per cent, while steel and brass have values of approximately 0.01 per cent.

Damping-capacity measurements generally are grouped into two classes—high-stress and low-stress. The first group includes all those measurements in which the specimen is subject to stresses over about 100 pounds per square inch, and they are made almost exclusively by subjecting the specimen to torsional stresses. One type of apparatus used for making these determinations is shown in Figure 10. The specimen is made into the form of a rod one-fourth-inch in diameter and five inches long with square ends one inch long and five eighths inch square. One end of the specimen is clamped in a metal frame securely fastened to a large cement block. The frame and the specimen can be seen to the right in Figure 10. A metal bar also visible is clamped to the upper end of the specimen and twisted enough to produce the desired stress in the specimen. The bar is held in this position by electromagnets and released when the test starts. The amplitude of swing of the bar is then recorded, and the decrement of the vibrations can be determined from this record. The specific damping capacity then will be

$$p = 200 \log_e \frac{A_{n+1}}{A_n} \text{ in per cent}$$

where A_n and A_{n+1} are the amplitudes for any two successive cycles. An approximate form is

$$p = (400/n) \frac{A_m - A_{m+n}}{A_m + A_{m+n}}$$

where A_m is the amplitude at the mth cycle and A_{m+n} is the amplitude n cycles later.

The motion of the swinging bar was recorded originally by direct tracing on a revolving drum by a pen attached to the bar, and later photographic recording was used. The electronic converter circuit described before has proved to be more convenient, and an a-c-operated converter is seen in the upper center of Figure 10. The

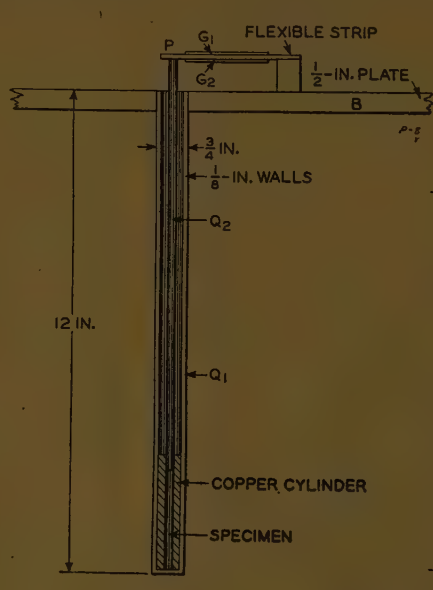


Figure 8

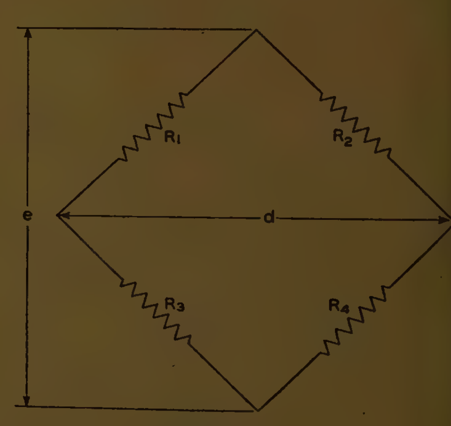


Figure 9

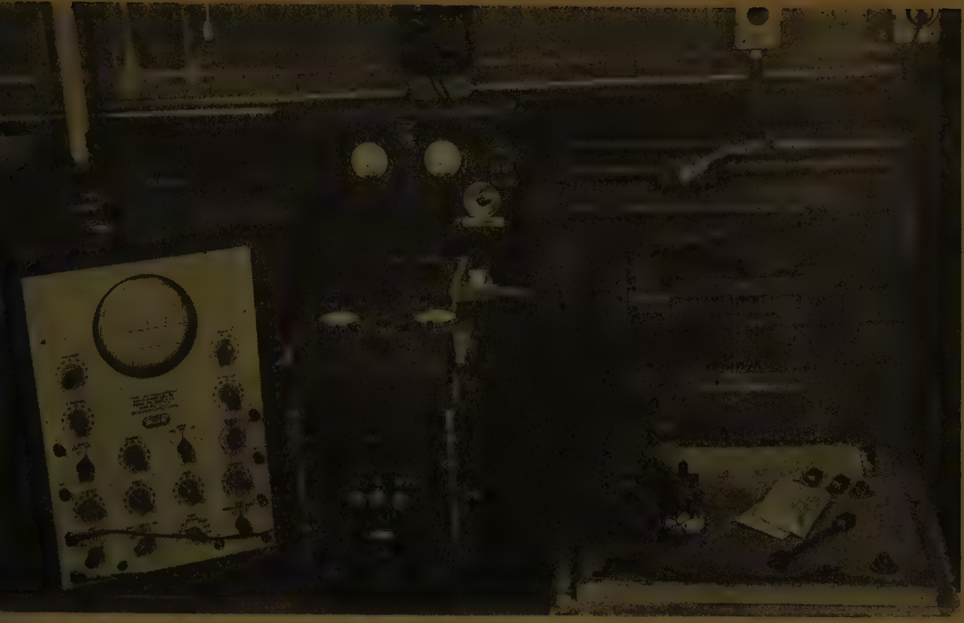


Figure 10. High-stress damping-capacity measuring instrument

notion of the bar is traced on a recording oscillograph is seen in the lower center of Figure 10. The capacitance hange required to actuate the converter is obtained from wo triangular electrodes mounted on the frame of the pparatus and adjusted so that they are parallel to and lose to the moving bar. The motion of the bar will hange the capacitance of the capacitors and produce hanges in the output current of the converter. This ar- angement has been used for several years, and, since the scillograph will give full-scale deflection for three milli- mperes of current, it requires only a capacitance change of .75 micromicrofarad to give a curve covering the whole ange of the oscillograph. The electrodes need not be arge, and the spacing between them and the bar can be onsiderable.

Low-stress damping measurements are generally those n which the stresses in the specimens are from 0 to 100 ounds per square inch. These measurements are made n two ways: in one case, the specimens are set into vibration and the decrement of the vibrations determined just as in the high-stress tests; in the other case, a method similar to one used for determining the resistance of tuned electric circuits is used. The specimen is mounted on suitable supports and caused to vibrate at a definite frequency by the application of electrostatic or electromagnetic force. The amplitude of the motion will vary with the frequency, being a maximum at the resonant frequency of the specimen.

In this case, a resonance curve is obtained by measuring the amplitude or velocity of the specimen vibrations at frequencies above and below the resonant frequency. Such a curve is shown in Figure 11. The damping capacity is a function of the width Δf of the resonance curve and can be calculated from the equation

$$p=200\pi\Delta f/f_0$$

where f_0 is the resonant frequency of the specimen.

In one type of apparatus for making such measurements, the specimen is a rod suspended at its center and excited into longitudinal vibration by an electromagnet at one end. The motion of the specimen is determined by measuring the voltage induced in the coil of another magnet at the other end. The motion is very small, however, and the induced voltage must be amplified as much as 50,000 times before it can be determined readily. An amplifier having a gain of 50,000 over a frequency range of 20 to 40,000 cycles per second is used for this purpose; a cathode-ray oscillograph is used for measuring the amplified voltage.

In another arrangement the specimen is clamped to a

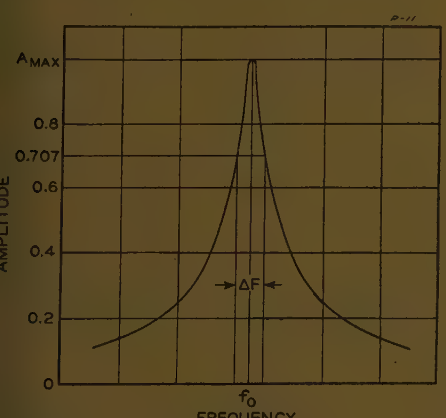


Figure 11. Resonance curve obtained by measuring the amplitude or velocity of the specimen vibrations at frequencies above and below the resonant frequency

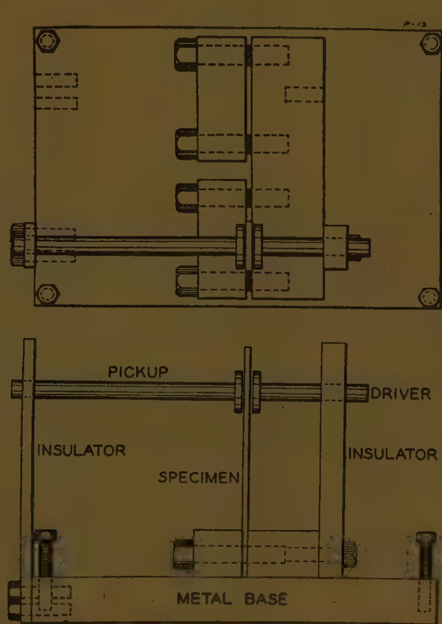


Figure 12 (right). Flexual damping apparatus

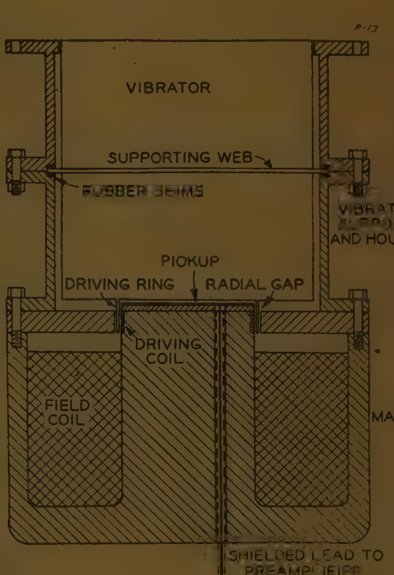


Figure 13. Cross section of sonic generator

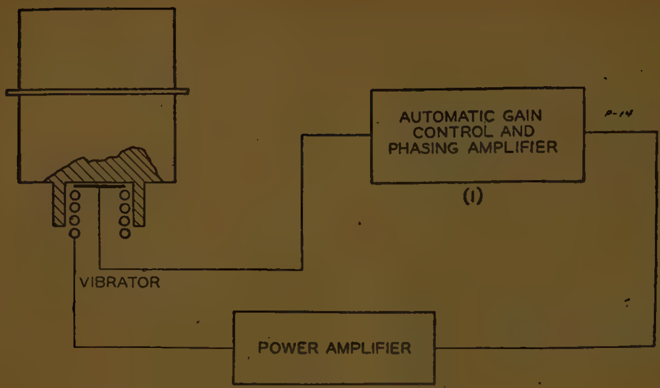


Figure 14. Block diagram of self-controlled sonic vibrator

heavy base at one end and driven at the other end by an electrostatic force. Such an arrangement is shown in Figure 12. A voltage is applied between the specimen and the driver electrode and the change in capacitance between the pickup electrode and the specimen is used to actuate the electrostatic converter circuit previously described. Either resonance curves or decrement measurement can be used with this apparatus.

The characteristics of the converter circuit are seen most clearly in this application. The potential gradient between the specimen and the driver electrode may be as many as 2,000 volts per inch and the pickup electrode is directly opposite, and, even though the specimen is small and offers little shielding effect, the output from the pickup shows no effect from the driving field. Also none of the connections from the pickup electrode and the specimen need be shielded.

In all the low-stress damping measurement, the modulus of elasticity can be determined at the same time that the damping is obtained. From theoretical studies, the resonant frequency of simple forms of specimens is related to the dimensions, density, and modulus of electricity in a simple manner. Thus, by determining the resonant frequency, density, and dimensions, the dynamic modulus can be calculated. These methods can be used on specimens too small for static methods.

In a few cases the changes in capacitance between the specimen and pickup plate in the low- and high-stress damping measurements have been used to modulate a frequency-modulated oscillator, and a simple frequency-modulation receiver was used to demodulate the signal for measurement and recording. This system worked quite well and had the advantage that the measurements and recording could be made at a considerable distance from the rest of the apparatus, but in general it has

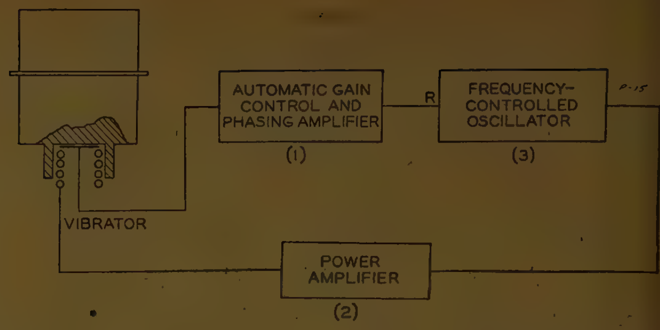


Figure 15. Block diagram of self-controlled sonic vibrator

no advantage over the direct connection to the converter circuit.

APPLICATION OF SONICS TO METALLURGY

The fact that sonic waves of sufficiently high frequency and amplitude would cause the flocculation of solid materials suspended in gases was discovered many years ago; it was thought that this might afford a convenient method for recovering suspended solid and liquid matter from smokes, fumes, and other aerosols. This application was considered first, but the effect of high-frequency waves on the flotation of minerals, on the deposition of metals in electrolytic processes, and on the degassing of metal melts also is being investigated. The primary problem, however, was the development of a suitable source of sonic waves, and a new type of sound generator was developed by the Bureau of Mines especially for this work. Its successful operation is dependent on special electronic circuits; and, since the generator itself already has been described in detail,[4] only a brief description of the essential parts of the generator will be given here.

The sound generator consists essentially of a vibrating member, an electromagnetic driving system, and an electrostatic pickup plate; a cross section of the generator is shown in Figure 13. The vibrating member of this

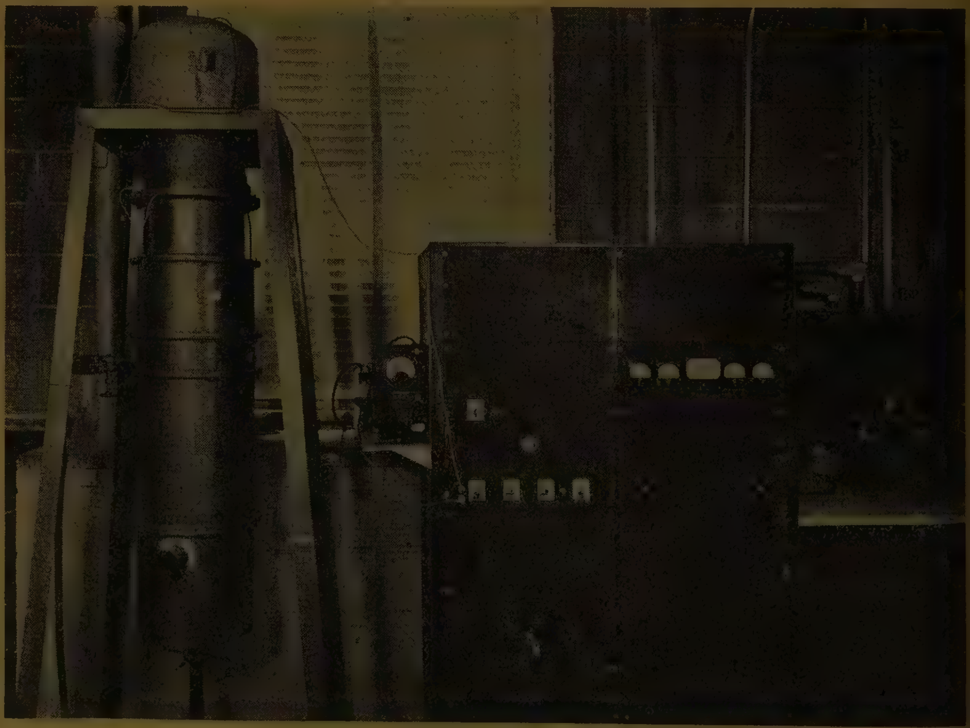


Figure 16. Sonic flocculating unit

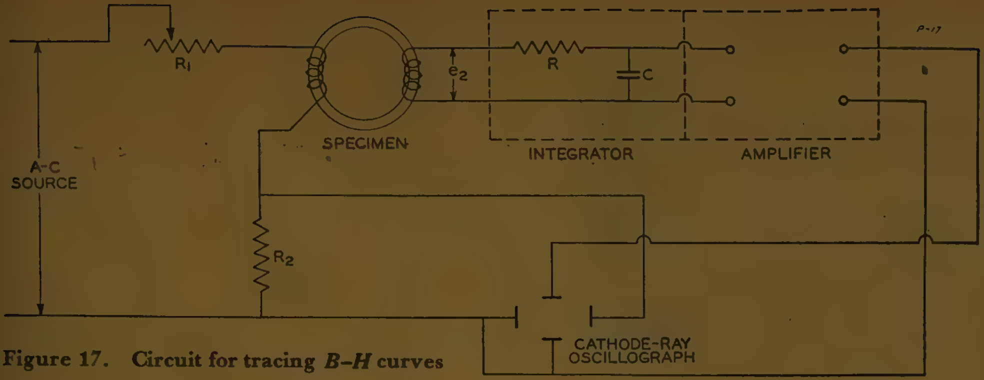


Figure 17. Circuit for tracing *B–H* curves

generator is a solid Duralumin cylinder supported at its midsection by a thin web which is an integral part of the cylinder. The cylinder is free to vibrate longitudinally as a free–free bar; the force producing the vibrations originates in a driving ring on one face of the cylinder. This ring is also an integral part of the cylinder. The driving mechanism consists of a pot magnet with a circular air gap, into which the driving ring fits, and a driving coil wound on the inner face of the air gap. The current to drive the vibrator passes through this coil and, by transformer action, induces a current in the driving ring. The interaction of this induced current with the radial magnetic field in the air gap of the pot magnet produces the force on the driving ring. The electrostatic pickup plate on the center pole of the pot magnet does not contribute directly to the operation of the generator but provides a means for controlling the vibrations. It is insulated from the magnet structure, and a connection is brought out through a hole in the center pole piece. The capacitance between this plate and the vibrator will vary with the motion of the vibrator, and, by suitable means, this capacitance change can be made to produce a voltage the amplitude, frequency, and phase of which are determined by the motion of the vibrator.

The force on the driving ring will be proportional to the product of the current induced in the driving ring and the strength of the field in the air gap of the pot magnet; it will also be in phase with the current in the driving ring which will be essentially 180 degrees out of phase with the current in the driving coil. At its resonant frequency, the cylinder will have its maximum velocity of motion which will be in phase with the driving force. For frequencies above resonance the velocity will lag, and for lower frequencies the velocity will lead. The same relative condition is true of the amplitude except all are displaced in phase by a 90-degree lag. The variation of velocity and amplitude with frequency is the same as the resonance curve shown in Figure 11. In this case, f_0 might be 17 kilocycles and Δf would be approximately one cycle per second. In order to maintain the amplitude of the vibrations near the maximum, it is necessary to maintain the driving frequency within ±0.2 cycle per second of the true resonant frequency. This is not so simple as it might seem, because the dimensions and elastic constants of the vibrator change with temperature, and the frequency may change as much as 100 cycles per second between its initial value and its value after operating for an hour.

Two driving systems were devised for operating these vibrators; a block diagram of the first is shown in Figure 14. The capacitance change in the pickup plate is converted in amplifier 1 into a potential and is amplified sufficiently to drive amplifier 2, which in turn supplies the power to drive the vibrator. The actual motion of the vibrator will vary with its acoustical load, and thus the voltage generated by the pickup will vary. It is necessary, however, to maintain a substantially constant power input to the vibrator driving coil. Also, the phase of the driving current must be correct relative to the vibrator motion in order to maintain the maximum amplitude of vibration. Thus, the amplifier 1 in Figure 14 was designed with an automatic gain control and a phase-shifting circuit, so that a constant output voltage could be maintained over a wide range of input voltages, and the phase of the output voltage can be changed through practically 360 degrees relative to its input voltage. This oscillator and amplifier circuit is described completely in St. Clair's article[4] and in a Bureau of Mines publication,[5] as well as in an article[6] in the Review of Scientific Instruments.

With this driving arrangement the driving frequency always remains at its optimum value when the phase has been adjusted properly. It has several disadvantages in that the circuit either oscillates or is completely inoperative, in which latter case an external source of voltage must be used to drive it instead of the voltage from its own pickup. Under heavy acoustical loading conditions, the vibrator motion may be so small that the amplifier gain is not sufficient to maintain the vibrations, and the system will cease to function. Also, the vibrations and driving power always are initiated at low amplitude and buildup gradually to a maximum, so that,

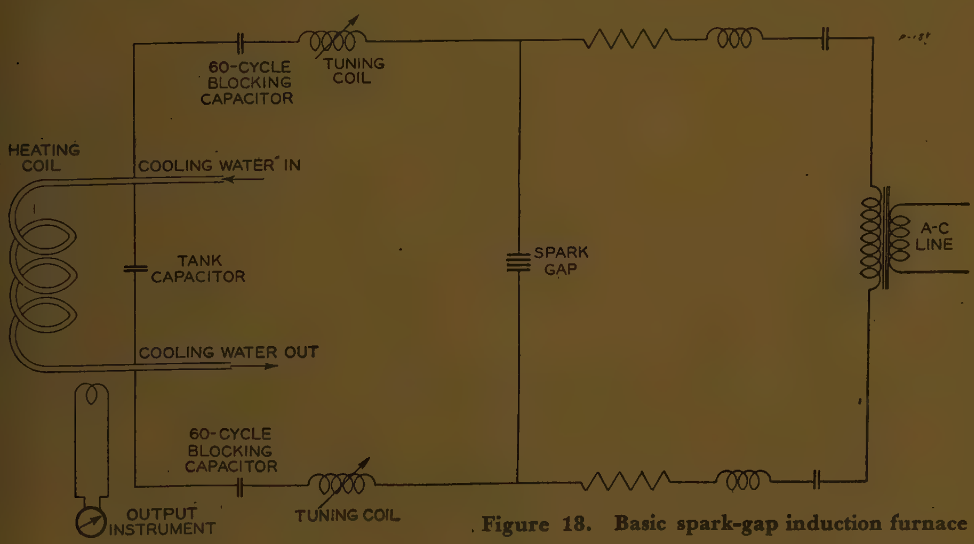


Figure 18. Basic spark-gap induction furnace

Figure 19. Induction furnaces

in borderline cases, where the gain in the system is barely sufficient to maintain oscillations, it may be difficult to get it started.

The other driving system is illustrated in the block diagram in Figure 15. In this case the automatic gain control and phasing amplifier 1 and the power amplifier 2 are the same as before, but an additional oscillator and amplifier circuit 3 have been added. The oscillations are generated in this unit and amplified to drive the vibrator; they are not dependent on the vibrator motion. The variation in phase of the pickup voltage with frequency is used to control the frequency of the oscillator. A complete description of this oscillator and amplifier circuit can be found in other publications.[5,6] When the automatic control is operating, it is possible to change the frequency of the oscillator by 900 cycles per second in 17 kilocycles, while the automatic control will compensate for this change and hold actual frequency within about ± 0.2 cycle per second of the proper resonant value. In addition, this driving system will function under the heaviest acoustic loading of the vibrator, and, even when the vibrator motion is too small for the automatic control to operate, the oscillator still will drive the vibrator if the frequency is adjusted manually from time to time. In addition, this driving system supplies maximum driving power at all times and makes it easier to get the vibrator into motion. A large sonic flocculating unit with a driving circuit capable of developing 2,500 watts of energy is shown in Figure 16.

MAGNETIC TESTING

The best method for determining the magnetic properties of metals is by regular permeameter measurements. In many cases, this equipment may not be available. Also, the accuracy of the permeameter methods may not be required, and the time required for making them will not be warranted. In such cases, it is possible to trace *B–H* curves directly on a cathode-ray oscillograph. A circuit for accomplishing this is shown in Figure 17.

The specimen is excited by an alternating current of low frequency 20 to 60 cycles per second. The secondary voltage e_2 is proportional to the rate of change of the flux density B, and this is integrated in the integrator circuit R, C. The voltage across capacitor C will thus represent the value of B in both phase and magnitude with very little error if the impedance of R is large compared to C at the operating frequency. The voltage across C will be small and must be amplified by a vacuum-tube amplifier having negligible phase shift over a frequency band which includes the operating frequency and a number of its harmonics. The amplifier output is used to deflect the cathode-ray beam in a vertical plane, and the voltage across the resistor R_2, which is proportional to and in phase with H, is used to deflect the beam in a horizontal plane. Thus a *B–H* curve is plotted automatically. If the apparatus is designed properly, and the frequency is low enough to eliminate skin effects, the curves thus obtained are sufficiently accurate for many purposes.

In cases where only the coercive force of a material need be determined, a coercimeter is used. This instrument does not involve electronic apparatus directly, but with magnetically weak material, d-c amplifiers[7] or resistance–capacitance-coupled amplifiers with good response at low frequencies have increased greatly the accuracy of the determinations and extended the scope of the instrument's usefulness.

INDUCTION FURNACES

In induction furnaces the heat is generated directly in the object to be heated or melted by means of eddy currents induced in the material itself. The magnetic field required to induce these currents is obtained from three types of electric generators and has frequencies from 15 kilocycles to 5 megacycles. The three sources of electric energy suitable for this work are the rotating electric generator, the resonant spark-gap circuit, and the vacuum-tube oscillator. The rotating electric generator is used for high-power capacitance, up to 250 kw, but its frequency is limited to about 15 kilocycles. For smaller sizes, up to 20 or 30 kw, the spark-gap circuit is used. Such a circuit is shown in Figure 18. The voltage across the secondary of the input transformer breaks down the spark gaps, and oscillations are set up in the circuit, the oscillating current passing through the heating coil and inducing eddy currents in the material to be melted. These circuits operate at frequencies from 80 to 200 kilocycles and use either air gaps or gaps enclosed in inert atmospheres. Electron-tube oscillators are used also, the frequency range being generally from 200 kilocycles to 5 megacycles.

The rotating-electric-generator type of furnace is very useful for preparing larger melts; two of these units are shown on the right-hand side of Figure 19. The spark-gap type is most useful for making small melts and samples, typical units being shown on the left-hand side of Figure 19. The electron-tube-oscillator type is more useful for heat treating rather than the melting of metals to make ingots and alloys.

CHEMICAL AND SPECTROGRAPHIC APPLICATIONS

In making chemical and spectrographic analyses, a number of electronic devices are used. The photoelectric densitometer has been developed, so that it can be used for measuring the density of the lines on spectrographic plates and for recording the values on a continuous chart.

Determinations of the pH of solutions are made almost exclusively with pH meters and electronic titrimeters, and conductivity bridges are used to make accurate titrations, especially in cases where the end points cannot be observed accurately by the eye. Polarigraphs are used for analyzing dilute solutions. In these instruments the variation of current through the solution with applied potential is determined, and sudden changes in current at critical values of potential are used to identify the elements in the solution. The magnitude of the changes can be used to determine the amount of an element present. Some of these instruments record the current–voltage curve automatically.

MISCELLANEOUS APPLICATIONS

A number of other cases where electronic devices are used could be found, a few of these being vacuum gauges, vacuum-tube voltmeters, rectifiers for electrostatic separators, bridge detectors, and sensitive relays. These devices are used extensively, and only a few will be explained.

A-c bridge circuits have been found very useful for making a number of measurements, such as the conductivity of aqueous electrolytes, the conductivity of molten salts, the magnetic properties of metals at high temperatures, and the motional impedance of vibrators. In these cases frequencies from 60 cycles per second to 40 kilocycles per second are employed, and suitable means for determining the balanced condition is very important. Some of the electronic circuits used for this purpose will now be described.

The simplest application is amplification of the unbalanced voltage increasing the sensitivity of measurements in the audible range many times. For inaudible frequencies, heterodyne methods are used to convert the frequency to the audible range before amplification.

Visual detectors, such as the so-called "magic-eye" tube, can be used by rectifying the amplified a-c signal. The response of all these detectors, however, is proportional to the amplitude of the signal and independent of phase, so that independent resistance and reactance balancing cannot be done.

The so-called wattmeter circuit makes it possible to make separate balances for resistance and reactance. One of these circuits using ordinary vacuum tubes and a milliammeter as an indicator is shown in Figure 20. The current through instrument M_1 will be proportional to the product, $e_1e_2 \cos\theta$, where e_1 and e_2 are the voltages indicated in the figure, and θ is the phase angle between e_1 and e_2. One of these voltages is supplied from the same source supplying the potential for the bridge circuit, and the other is the detector voltage. By shifting the phase of one relative to the other, the reading on instrument M can be made to respond to only one component of the detector voltage, e_2. The balancing is made much simpler in some cases.

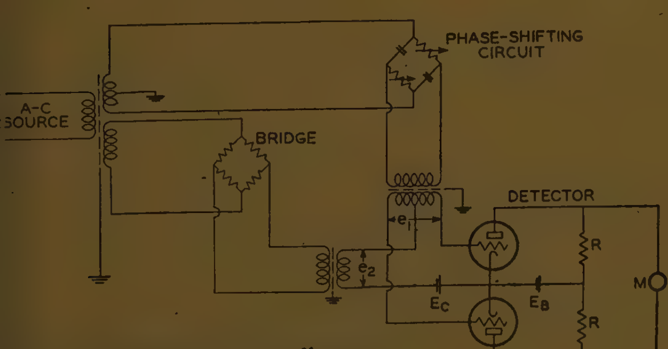


Figure 20. Bridge detector diagram

The great sensitivity of electronic tubes to changes in grid voltage, and the small amount of grid current required to operate them make them very useful as relays. In one case, a thyratron tube is used to determine the point at which the diamond point on a microhardness tester touches the specimen. The circuit operates from any 60-cycle a-c power supply, and the thyratron has a negative grid bias when the metal tube holding the diamond is resting on its support. As soon as the diamond penetrates the proper distance into the specimen, however, the metal tube is lifted from its support and opens a circuit, placing a positive bias on the thyratron. The tube then becomes conducting, and a light in the plate circuit indicates that the diamond impression has been made in the specimen. The extreme sensitivity of this electronic relay makes it possible to reproduce the value of the pressure on the diamond point very closely in making a series of tests, a factor which is extremely important in determining microhardness values.

Another type of electronic relay uses a tube with a diode and a triode element. The diode rectifies the alternating current and supplies direct current for the triode. The grid bias on the triode is changed by external contacts in the grid circuit. This relay is used in a constant-temperature bath, a mercury-column temperature regulator providing the contacts. The change in plate current then will operate a relay and regulate the heating power going into the bath. Temperature control within ± 0.005 degree centigrade can be obtained readily without an inert atmosphere above the mercury column, because practically no current flows through the contacts, and the voltage is small, thus eliminating troubles from oxidation at the mercury surface.

CONCLUSIONS

In conclusion, the afore-mentioned uses of electronic devices in metallurgical research are based chiefly on the work done by the Bureau of Mines, and the general scope by no means is limited to the specific applications mentioned in this article. The cases mentioned will serve to indicate what can be done by electronic means, however, and will show the valuable contribution electronic developments have made toward improving older methods and opening new methods of approach to metallurgical problems.

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INSTITUTE ACTIVITIES

North Eastern District Meeting an Outstanding Success

A very successful wartime technical meeting of the AIEE North Eastern District was held in Boston, Mass., April 19 and 20, 1944, with headquarters in the Hotel Statler. Eight technical sessions and a special session to observe the AIEE 60th anniversary were held during the two days of the meeting, which was preceded by the tri-Sectional technical-paper competition among the Lynn, Pittsfield, and Schenectady Sections on the evening of Tuesday, April 18. Many of the presentations illustrated the electrical engineer's contribution to the war effort in a wide variety of specialized fields. The total attendance was approximately 630, which is appreciably higher than attendance figures for North Eastern District meetings in the past ten years and probably an all-time high for a North Eastern District meeting.

TRI-SECTIONAL COMPETITION

At the technical-paper competition for the younger engineers, first prize was awarded to P. J. Lebenbaum of the Lynn Section for his paper, "Rating Machines—High Altitude," which received 680 points, and second prize to D. K. Hartman of the Pittsfield Section for his paper, "Problems at Boulder Dam," which received 676. All presentations were of such a high order that the decision of the judges resulted in a tie between the Pittsfield and Schenectady Sections, each receiving 1,296 points, and the Lynn Section was not far behind with a total of 1,262 points. The plaque donated by P. L. Alger was presented by vice-president K. B. McEachron to the Schenectady Section to be held for the first six months, and then to be turned over to the Pittsfield Section to be held for the last six.

The judges of the competition were C. A. Corney, R. T. Henry, and H. M. Turner. The audience partly assisted in rating the oral presentations by ballot. President Nevin E. Funk commented briefly on the work of the Institute and the need for putting forth effort to derive the benefits from it. National Secretary H. H. Henline complimented the speakers on their excellent presentations, which were very well illustrated with graphs and charts. R. W. Adams was the presiding officer.

STUDENT TECHNICAL SESSION

A well-attended student session, in which five papers were presented, was held Wednesday morning. The meeting was addressed by President Funk, who complimented the students on their activities and excellent presentations. The first prize was won by H. G. Ryan of Northeastern University, and the second prize went to C. J. Hooker, Jr., of Massachusetts Institute of Technology. G. Minalga presided. The following papers were presented:

METHOD OF MAGNETIC RECORDING. **C. J. Hooker, Jr.** Massachusetts Institute of Technology

VACUUM-TUBE VOLTMETER WITH CATHODE FOLLOWER. **J. B. Angell and A. B. VanRennes,** Massachusetts Institute of Technology

VARIABLE-FREQUENCY 25-CENTIMETER OSCILLATOR. **H. G. Ryan,** Northeastern University

ELECTRONICALLY REGULATED BIAS SUPPLY. **R. W. Bordewick and D. R. King,** Northeastern University

METHODS OF CONDUCTING STUDENT BRANCH ACTIVITIES WITH ARMY, NAVY, AND CIVILIAN STUDENT BODIES. **Joseph E. Bambara,** apprentice seaman, United States Naval Reserve, Cornell University

BRANCH COUNSELORS' LUNCHEON MEETING

After the student technical session a luncheon meeting of approximately 20 Branch counselors, students, and Institute officers was held, with R. G. Porter, chairman of the District committee on student activities, presiding. H. W. Bibber, counselor at Union College, explained that, with the transfers from other institutions, social activities were more important in his Branch than heretofore. F. N. Tompkins, counselor at Brown University, commented on his Branch holding joint meetings with other Branch organizations. E. T. B. Gross, counselor at Cornell University, reported on a successful meeting of his Branch, addressed by the director of the college of electrical engineering, which had been held so that the transfers from other Branches could become acquainted. He explained that it was necessary to put the Student Branch at Cornell University on a term basis and that the Branch is fortunate in having in the Ithaca Section some officers who are also in Branch work. He stated that the Section programs were also suitable for students. It was announced that the Schenectady Section had held a dinner for the Union College Branch, which was attended by AIEE Past President D. C. Prince, Everett S. Lee, and A. C. Stevens. The students were seated between members of the Section and thus given the opportunity to become better acquainted with them.

Vice-President K. B. McEachron addressed the Branch counselors' meeting and suggested that the counselors and the Student Branch chairmen should use their ingenuity in building the Branches, as the old methods would not always be successful under present existing conditions. He urged that the good ideas and successful experiments of the Branches should be reported to Institute headquarters.

National Secretary Henline said that 663 Student Branch meetings were reported held or definitely scheduled up to April 10, and he estimated that approximately 700 to 750 meetings would be held during the fiscal year. This compares with an average of 1,257 meetings held during the fiscal years 1938 to 1941, and an average of 944 meetings for the years 1941 to 1943. He advised that one Branch, which had discontinued in the belief that it would not be possible to resume activities until after the war was now reorganized and active again. All Branches were urged to retain their organizations and carry on their activities as well as possible under existing conditions.

The Branch counselors' meeting also was addressed by President Funk and Director R. G. Warner, both of whom felt encouraged by the student activities as demonstrated. The counselors present decided that a meeting of Student Branch counselors should be held within the District next year. H. W. Bibber, E. T. B. Gross, and K. L. Wildes were appointed a committee to handle the balloting for the chairmanship of the District committee on student activities.

AIEE 60TH ANNIVERSARY OBSERVANCE

One of the features of the meeting was a special session held to commemorate the 60th anniversary of the Institute, at which addresses were given by President Funk, Past President Prince, and a representative of the American Airlines, Inc. President Funk in an address entitled "History of the Institute" told where the history can be found, the trends, and the wartime activities. Past President Prince in an address entitled "Future of Electrical Engineering and the Institute" referred to a number of developments in connection with the war effort which might be made available for civilian use in the postwar period, provided there is a sufficient commercial demand. Mr. Prince is chairman of the General Electric Company postwar committee. The representative of the American Airlines, Inc., presented an address on "The Future of Aeronautics," prepared by Edward J. Foley of the American Airlines, Inc., postwar committee, which presented the future possibilities of the commercial airlines after the war, and he presented as problems to be solved, the variable-voltage output of generators and electrical developments required to operate auxiliaries, as well as refinements in lighting for commercial planes. The meeting was conducted by Past President D. C. Jackson, who is chairman of the 60th anniversary observance committee of the North Eastern District.

GET-TOGETHER DINNER

The get-together dinner, with a group of good speakers and William H. Timbie acting as toastmaster, was a memorable occasion. The principal speaker of the evening was William S. Newell, president of the Bath Iron Works, whose subject was "Some Thoughts on the Immediate Future." Mr. Newell was introduced as having worldwide fame for building destroyers. In

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Future AIEE Meetings

Summer Technical Meeting
St. Louis, Mo., June 26–30, 1944

Pacific Coast Technical Meeting
Los Angeles, Calif., Aug. 29–Sept. 1, 1944

Annual Meeting

The annual meeting of the American Institute of Electrical Engineers will be held at the Hotel Jefferson, St. Louis, Mo., at 10 a.m. on Monday, June 26, 1944. This will constitute one session of the summer technical meeting.

At this meeting, the annual report of the board of directors and the report of the committee of tellers on the ballots cast for the election of officers will be presented.

Such other business, if any, as properly may come before the annual meeting may be considered.

(*Signed*) H. H. HENLINE
National Secretary

respect to the future and in particular reference to the shipbuilding industry, Mr. Newell explained that, if costs, fixed charges, and inventories were kept down, the industry would be in good shape. He suggested a plan for demobilization, and in conclusion stated that "money, men, and industry must be accorded the same incentives that have been effective in the past."

The meeting was opened by Thomas Cooper, Jr., general chairman, who welcomed the members and guests in attendance and expressed appreciation to the members of his committee for the arrangements made. He explained that the purpose of the meeting was to provide an opportunity for the exchange of ideas and information through the medium of the presentation of technical papers, thus aiding the war effort.

Greetings of the Commonwealth of Massachusetts from Governor Saltonstall were extended by Senator Jarvis Hunt, who expressed appreciation for what electrical engineers are doing for the war effort.

The District prize for best paper was presented to S. Minneci and S. B. Farnham by Vice-President K. B. McEachron. The paper was entitled "A New Control System for Automatic Parallel Operation of Load-Ratio-Control Transformers."

President Funk congratulated the general committee on the success of the meeting, which almost approached the scope of national meetings in character. He expressed the belief that the decision of the board of directors to continue technical meetings during the war is fortunate, because the meetings and many of the papers presented are pointed toward hastening the end of the conflict. The dinner was attended by 567 members and guests.

TECHNICAL SESSION

Seven technical sessions were held during the meeting on subjects as follows: cables, transformers and selected subjects, electronics, power transmission, air transportation, electrical machinery, and industrial power applications. If attendance is indicative of the interest in various subject matter, then electronics and industrial power applications proved to be the most popular, with attendances of 240 and 165, respectively. The papers presented in the electronics session dealt with the development and operation of rectifiers, as well as the control of d-c motors and the application of broad-band carrier systems to telephone cables. The papers in the industrial-power-applications session dealt with voltage regulation, capacitors, power supply for resistance welders, motor control and maintenance, as well as variable-speed drives, and electronic heating, which represented well diversified subject matter in the industrial field.

NATIONAL . . . .

War and Postwar Topics Scheduled for St. Louis Meeting

The tentative program for the AIEE summer technical meeting to be held in St. Louis, Mo., June 26–30, 1944, promises that it will be the largest summer technical meeting program in the history of the Institute. Arrangements are being made for some 30 technical sessions and conferences, in addition to the annual meeting to be held on Monday, June 26 and the conference of officers, delegates, and members. The occasion also is fitting for a record-breaking program as it will mark the celebration of three important anniversaries in the electrical field—the 60th anniversary of the AIEE, the 100th anniversary of the Morse telegraph, and the 40th anniversary of the International Electrical Congress, which met at St. Louis in 1904. Headquarters for the summer technical meeting will be in the Hotel Jefferson, which has good facilities and some air-conditioned meeting rooms.

TECHNICAL SESSIONS AND CONFERENCES

Several of the technical sessions and conferences will treat subject matter which directly or indirectly aids the war effort. Many new developments to be discussed also will be of great value in the postwar period. Among the sessions and conferences aiding the war effort are: four air-transportation sessions, electric welding, induction heating, and quality control by statistical methods in manufacturing. This latter conference, as well as a conference on electric heating of houses, is especially pertinent to the postwar period.

Several of the sessions which indirectly aid the war effort are of particular interest to the central-stations industry. These are: power generation, power transmission, cables, switchgear, relays, electronic-frequency converters, and power-system applications of carrier current.

Still other sessions and conferences will deal with the following subjects: land transportation, basic sciences, communication, education, electrical machinery, industrial power applications, electronics, X-ray tubes, instruments and measurements, and electrochemistry and electrometallurgy.

REGISTRATION AND HOTELS

Members desiring to attend who receive an advance registration card should fill in and return the card promptly. Hotel reservations should be made by writing directly to the hotel preferred.

COMMITTEES

Those making the arrangements for the meeting are B. D. Hull, *chairman;* I. T. Monseth, *vice-chairman;* L. L. Crump, *secretary-treasurer;* F. A. Cooper, Jr., *chairman,* St. Louis Section. Subcommittee chairmen: C. B. Fall, *finance;* C. H. Kraft, *meetings and papers;* B. T. McCormick, *registration and information;* R. G. Meyerand, *hotels;* E. S. Rehagen, *hospitality;* Guy W. Thaxton, *transportation and trips;* L. F. Woolston, *publicity.*

Special Committee to Study Employment Conditions Named

The special committee authorized by the board of directors January 27, 1944 to study employment conditions (*EE, March '43, page 107*) has been designated the committee on collective bargaining and related matters. All but one of the members have been appointed.

The committee members are: I. M. Stein (F '39) director of research, Leeds and Northrup Company, Philadelphia, Pa., *chairman;* O. W. Eshbach (F '37), dean, Northwestern Technological Institute, Evanston, Ill.; W. R. Hough (M '41), engineer in charge of a-c motor design, Reliance Electric and Engineering Company, Cleveland, Ohio; A. C. Streamer (M '41) vice-president, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.; Bartow Van Ness, Jr. (M '35) chief engineer, Safe Harbor Water Power Corporation, Baltimore, Md.; E. P. Yerkes (F '40) engineer of equipment and buildings, Eastern area, Bell Telephone Company of Pennsylvania, Philadelphia. Mr. Stein and Mr. Yerkes also are AIEE representatives on the joint committee with the American Society of Mechanical Engineers on the same subject.

Postwar Electric-Power Development Debated by AIEE New York Section

How co-operative effort between Federal and State regulatory bodies and the power companies can contribute to full development of electric power in the postwar period was aired at a meeting of the power and industrial group of the AIEE New York Section, April 11, 1944. Four scheduled addresses by spokesmen of both the commissions and the power companies covered the various aspects of the subject. The meeting attracted top executives from many of the largest power systems in the United States, especially those having offices in New York. Group Chairman Robert T. Oldfield, senior electrical engineer, New York State Public Service Commission, presided.

Chairman Leland Olds of the Federal Power Commission, Washington, D. C., offered specific suggestions as to how the electric-power industry can meet the challenge of the postwar period. The industry must recognize, he said, that "private enterprise is a trusteeship and must act accordingly. Self-regulation motivated by this moral concept will render government regulation less and less necessary. Toward this objective the power industry has a great opportunity to show the way, and I can assure the men of the industry that we of the regulatory bodies will co-operate."

Expressing disagreement with the policy of the Federal Power Commission, insofar as it seeks to regulate the business of electric utilities doing a wholly intrastate business, Judge Gay H. Brown, former counsel to the New York State Public Service Commission, vigorously defended States' rights in the regulation of such utilities. He cited instances wherein the Federal Power Commission allegedly had gained or sought to gain regulatory control over power companies doing a wholly intrastate business. He urged Congressional enactment clearly defining the authority of the Federal Power Commission as an effective remedy to resist encroachments on state jurisdiction.

The power companies point of view was presented by AIEE Past President John C. Parker, vice-president, Consolidated Edison Company of New York, Inc., who declared that the central-station art must develop responsively to the desires of a free people "so the producers of that service must, to the maximum degree compatible with the general social interest, be free of academic predeterminations and actively responsive to the compulsions of contemporaneous development." He said that wise and tolerant men within the electric-power industry "will cheerfully accept all restraints under law which keep them from wrongdoing and from imposing restraints either by omission or by commission on the communities which they serve."

Stressing the importance of cheap electric power in any community or state that wishes to maintain its industrial importance or to build up its industrial economy, Milo R. Maltbie, Chairman of the New York State Public Service Commission, discussed the place of the power companies in New York State during the postwar period. (As Doctor Maltbie, although present at the meeting, was recovering from a recent illness, his address was read by Maurice C. Burritt, a member of the New York Commission.) Doctor Maltbie pointed out that the principal factors that will enable the power industry to contribute to the continued industrial, commercial, and agricultural progress of the Empire State are: cheap money, adequate reserves, and a reasonable surplus. Companies having a financial structure based upon sound conservative accounting and adequate reserve not only will weather the storm of postwar reconstruction, but also will be able to perform the postwar functions with ease, he declared.

Abstracts of the four addresses follow.

RECAPTURE COMPETITIVE VIEWPOINT SAYS CHAIRMAN OLDS

Predicting that the postwar period will provide industry with a far more difficult test of its devotion to the country's service than the war period with its unlimited consumption, unaffected by costs or prices, Mr. Olds recommended that industry adopt the positive attitude of asking, "How can we sell as much power as during peak war production, and more?" rather than asking, "Will there be a market?"

With the expansion of service set as the postwar frontier Mr. Olds went on to define the postwar power objective in terms of the country's electric-energy requirements. On the basis of supplying energy for full industrial employment, plus the expansion of other classes of energy consumption to provide a steadily rising standard of comfort for the nation, and giving due consideration to reduction in demand and possible new consumer outlets, Mr. Olds placed the objective of the power industry for the end of the first postwar year at an annual rate of between 200,000,000,000 and 220,000,000,000 kilowatt-hours. This amount would be in addition to any power generated in industrial plants and may be compared with about 235,000,000,000 kilowatt-hours which the industry estimates will be generated for public use in 1944. For the end of the fifth postwar year he raised the objective to 270,000,000,000 kilowatt-hours. In specifying these figures, Mr. Olds stressed the fact that he was setting objectives and not forecasting demands.

He praised current ideas of postwar objectives stated in terms of greatly expanded consumption of electricity and adjustment of rates to make it possible. Declaring that the possibilities of expansion become apparent only from a competitive as opposed to a monopolistic viewpoint, Mr. Olds reviewed the tools at hand for restoring competition as a practical force in our economy. He characterized the Federal Power Commission's annual publication of typical electric bills throughout the country as the simplest competitive yardstick for stimulating investigation of costs by publicizing the prices a producer would have to meet to supply a consumer anywhere in the United States. He demonstrated by specific example how an executive of a company could be led, by comparison of his company's rates with those of another with the same cost problems, to a re-examination of costs ordinarily accepted under monopolistic operation. Mr. Olds added that this detrimental acceptance of costs indicates "a point at which monopoly in the power business, even with the help of able regulators, has failed to provide the possibility of full use of resources that would have been offered by free competition."

"I have never heard of a power system assigning a group of engineers to the task of determining the lowest possible price at which electricity could be sold," he said. He declared that engineers more often are given the task of justifying exsiting rates based on unchallenged costs.

Two other yardsticks for competitive unit-cost tests recommended by Mr. Olds were the Federal Power Commission's annual, "Statistics of Electric Utilities in the United States," and the Commission's, "Directory of Electric Generating Plants." Through these two publications the executive can compare his costs, function by function, with those of his potential competitors.

The striking differentials found in power-company statistics should be "flags, calling attention to matters that should be subjected to managerial analysis," he averred. The relatively high rate of return and the relative abundance of high executive salaries in the industry should be justified by demonstrated efficiency on the part of management, he said. The criterion in the electric field, he asserted, should be the achievement of unusually low costs and rates.

Calling write-ups and the amortization of other excesses over original costs such as the earlier capitalization of intangibles major handicaps to any utility company striving for a postwar outlook of the greatest possible expansion, Mr. Olds urged the adoption of uniform systems of accounting. Uniformity of accounting would not destroy private enterprise, as has been charged, said Mr. Olds, but rather would establish electric-utility accounting on a sound investment basis. Mr. Olds illustrated this contention with the example of a utility company which had reduced its operating expenses $485,000 in two years.

Stating that the obstacles to the full use of power which would vanish in a truly competitive economy must be removed, Mr. Olds upheld the work of the regulatory commissions. He described them as working "to establish an increasing approximation to the capital structure which could be maintained, with maximum security to investors, in a competitive economy. He designated the opposition of certain holding company groups as "reactionary, not conservative. If it were to succeed it would defeat its own ends."

In summation of a program with which the power industry can meet the challenge of the postwar period, Mr. Olds presented the following outline:

1. The industry should accept the obligation which would be enforced by real competition. Each company should set itself difficult sales objectives and should establish rates which would attain those objectives in the face of the most effective competition.

2. To this end the industry should extend cost controls along the lines just discussed. No longer should the costs of a given company be considered sacrosanct.

3. The industry should recognize that, if it reaches a point where it can no longer invest its depreciation reserves in the business, private enterprise will have reached a critical period, for it will be an admission that private capital in this field is no longer enterprising.

4. The industry should form concrete plans for transferring the economies of wartime power pooling to the postwar era. Integrated methods of operation, which would not render the corporate structure unwieldy or so extensive that the industry could not identify itself with the local interests served, should be considered.

5. The industry should assist in broadening the country's economic base through reversing the trend toward industrial centralization and furthering the development throughout the land of a balanced rural-urban economy.

6. The industry should co-operate in the new unitary approach to conservation and utilization of the country's natural resources. This requires establishment of a constructive relationship to the Government's program of water-power development.

RETAIN STATES' RIGHTS URGES JUDGE BROWN

Declaring that the states can adequately regulate the intrastate electric utilities, Judge Gay H. Brown at the outset of his address expressed complete disagreement with the policy of the Federal Power Commission insofar as it seeks to regulate the business of electric utilities doing a wholly intrastate business. Now associated with the law firm of Brown, Ryan, and Kenny, New York, N. Y., Judge Brown was formerly counsel to the New York State Public

rvice Commission, and justice of the ew York State Supreme Court.

Judge Brown pointed out that Congress ssed legislation in 1935 establishing the risdiction of the Federal Power Comssion, this legislation providing that 'ederal regulation shall extend only to ose matters not subject to regulation by e states." By means of specific examples, then showed how the Federal Power ommission had established jurisdiction er power companies doing an entirely trastate business but having interconctions with systems doing an interstate isiness. "The Commission claims," he id, "that, where a utility doing wholly trastate business owns facilities over which me energy is transmitted that finds its ay into another State, or if it owns facilities er which any energy received from another ate is transmitted, it is a utility under the risdiction of the Federal Power Comission." This jurisdiction includes regution of accounts and records; determiation of legitimate cost and depreciation; ntrol of acquisition of stock, sale, or lease property, and merger or consolidation. e also pointed out that the Commission s extended its jurisdiction over the rivers the United States to include any stream at could be made navigable by a vessel awing only two feet of water, even at eat expense; this would give the Comission control over practically all the hydroectric developments in the country.

Characterizing the cases he cited as amples of invasion of States' rights, Judge own declared that the only effective medy to resist such encroachments is by ongressional enactments that will clearly fine the authority of the Federal Power ommission.

PARKER PROPOSES FREE ENTERPRISE REGULATED BY NATURAL LAW

At the outset Doctor Parker defined his proach to the postwar course of power roduction and distribution as a highly ntative one but one that embraced the inciples of free enterprise regulated by atural law. He warned that a cart-beforee-horse economy would result unless first ings were given first importance in any ostwar consideration, or if the cause and fect relationship was misunderstood.

It is the province of engineers, Doctor arker stated, not to write prescriptions r the future nor to assign the "summum onum" to a society whose good is fundaentally subjective to its own aspirations nd desires, but to appraise realistically me of the facts of life in that society. A rst consideration of such an appraisal is a ear concept of the place which our parcular art takes in the general social and onomic scheme of that society.

It is not deprecatory of the economic and cial significance of power development, he ntinued to realize that it is by no means primary factor in human advancement, or even an end in itself; and that, though ighly important, it is not in any sense an bsolute essential. Electric power, enorously convenient as it is, is still a long way om being indispensable in the sense that e biologic or even the spiritual necessities life are essential.

Because power systems have been so inaluable an aid to the development of dustry and living, it is an easy matter for us to succumb to the fallible belief that the more we have of that particular service the better off we shall be, Doctor Parker explained. Increasing by little or by much the physical capacity of our power systems will not add one iota to the standard of American living nor of American production on which that living must depend. The ability to use must be present first, and only then does our ability to supply gain significance.

Unless the industry of the country finds itself in a social and economic climate conducive to vigorous growth, there will be no increasing use for industrial electric power, whether it be generated centrally or locally, whether it be produced cheaply, expensively, or by subsidy through the taxation of the individual. It is of no consequence how much electricity is available to the homes and farms, or whether the present service charges are decreased or not; there will be no increasing use for electricity unless research and development and commercial distribution of the devices of utilization make that use possible. Even so, there will not be any increasing use unless the people have the means of acquiring these devices and the homes and farms on which to use them.

What is important is that a vigorous and free economy in all fields shall be fostered, whereby the last trivial desire of the citizen may be satisfied if he is willing to work for it, whereby he will be free to accept or to reject what is offered. In our own particular field of power engineering, Doctor Parker stressed, it would mean that such an economy would allow the central power supply to function empirically and not by a predetermined course, anticipating postwar needs as successfully as it has done in the years of preparation for and engagement in combat.

CHAIRMAN MALTBIE STRESSES IMPORTANCE OF CHEAP ELECTRIC POWER TO INDUSTRY

"Of all the various classes of public utilities," stated Doctor Maltbie in his address, "probably none will be subject to more change and readjustments to meet new conditions than transportation and power. Each will have its own peculiar problems but the two will overlap in at least one direction." He then discussed the feasibility of electrifying the main line of the New York Central Railroad in New York State, but pointed out that the role played by electric power in improved transportation facilities is not so important as in industry. "Electric power is an important factor in the cost of manufacturing thousands of articles," he said, "and in many instances it is such an important part of the total cost that the location of industries is in large part and often in major part determined by the price at which electricity can be obtained. Combining all considerations . . . it is clear that in any community or state that wishes to maintain its industrial importance or to build up its industrial economy, the importance of cheap electric power cannot be overestimated."

Paying tribute to the performance of the power companies in New York State during the war, Doctor Maltbie said that: "Notwithstanding certain prognostications to the contrary, there has not been, so far as the Public Service Commission has been able to ascertain, any place in the State of New York where any industry or any industrial development has not been able, even during the last five years of unparalleled expansion, to obtain all the electric power which it desired at the rates then being charged." He hastened to add that every demand has not always been met instantaneously but declared that such instances were generally but minor blemishes on the whole power situation.

"In the discussion of postwar conditions and the part which the power industry will play therein," Doctor Maltbie continued, "one should assume that either through private companies or through the development of governmental facilities, all power demands in the State of New York will be met without any appreciable delay. But when this has been said, we have only started upon the solution of the problem. The fundamental question is not whether at some price electric power will be available to all who are willing to pay that price, but whether electric power will be supplied at the lowest possible cost . . .

"We come then to the question: 'What needs to be done in order that the power industry shall be prepared to make its contribution to the continued industrial, commercial, and agricultural progress of the Empire State?'

"The first factor to be mentioned, possibly not the most important but certainly near the top, is cheap money. Available funds flow freely to all parts of the United States where attractive investments are offered; but everyone knows that speculative or uncertain enterprises cannot obtain capital at as low cost as those in the investment class where risk and uncertainty have been reduced to a minimum. . . .

"Another factor is the extent to which reserves which have been built up meet depreciation and possibly contingencies, such as deferred maintenance or deferred reconstruction which exist in the case of many transportation facilities. Another is the extent to which a reasonable surplus has been provided to cushion any sudden and unusual contingency which could not have been foreseen. . . .

"That company," Doctor Maltbie concluded, "which today has a financial structure based upon sound conservative accounting and adequate reserves is the one which not only will weather the storms of postwar reconstruction, but also will be able to perform its function in the postwar world with ease—safety to its investors and adequate service at reasonable rates to the public."

He closed with a tribute to the utilities that "may not have made the headlines but which were conservatively financed, well engineered, and efficiently operated. Most of them are small, but they are a credit to their communities; their backers can face any investor to whom they recommend the purchase of securities; they will play a prominent and constructive part in our postwar world."

Logan Addresses AIEE Sections on Illumination Service Tour

H. L. Logan (F '43) managing engineer, Holophane Company, Inc., New York, N. Y., addressed several of the AIEE Sections during

his two-month lecture tour of western and southern United States and Mexico in the interests of illumination service. Mr. Logan, who is chairman of the illumination group of the New York Section of AIEE, and the New York section of the Illuminating Engineering Society, spoke on "Light and Safety."

Included in his schedule were lectures before AIEE Sections in Oklahoma City and Tulsa, Okla.; San Francisco, Calif.; and Wichita, Kans.; and before joint AIEE–IES sessions in St. Louis, Mo., and Houston, Tex. Besides engineers, his audience was comprised of other local groups interested in eyesight conservation and safety illumination. Early in June he will speak before the AIEE Mexico Section in Mexico City.

Active Aeronautics Group Interests Dayton Section

A successful series of meeting programs arranged by its new technical discussion group on electrical engineering in aeronautics will be terminated in May by the Dayton Section with a debate between the proponents of alternating and of direct current for the operation of aircraft equipment. The discussion group was suited particularly to the Dayton area because of the proximity of the headquarters of the Army Air Forces Matériel Command at Wright Field, and the Air Service Command at Patterson Field. Moreover many Dayton industries are occupied in manufacturing aircraft equipment.

At the first trial meeting held in February, at which A. W. Braden, major in the electrical laboratory of the AAF Matériel Command presided, there was an attendance of 130 from a membership of about 160. Three 20-minute talks followed by 20 minutes of discussion were scheduled. However audience participation in the discussion was so lengthy that later meetings were limited to two prepared addresses. Topics for the March, April, and May meetings were selected from the preferences expressed by those attending the February meeting.

"D-C Electric-Power Systems in Aircraft" was discussed by R. H. Kaufmann (M '41) of the industrial engineering department, General Electric Company, Schenectady, N. Y., at the February meeting. He presented the problems of paralleling d-c generators in aircraft and methods of making the d-c system "live in harmony." The causes of brush wear at high altitudes and the difficulty of simulating these conditions for test purposes were explained by H. J. Finison (A '43) of the electrical laboratory of the AAF Matériel Command in his speech, "High-Altitude Brush Wear on Rotating Machines." A talk on "Aircraft Lighting" delivered by A. D. Dircksen (A '43) of the AAF electrical laboratory completed the first program. Major Dircksen described the development of ultraviolet aircraft lighting and displayed samples of units and auxiliaries employed since the inception of this method of lighting. He also demonstrated actual units in use.

The March program comprised a discussion by Major Braden of the place of a-c power in the future airplane and the experimental work which has led to its present use in aircraft entitled, "A-C Electric-Power Systems" and a speech, "D-C Power Equipment for Aircraft Radio," by I. H. Gerks, lieutenant colonel of the Signal Corps' aircraft radio laboratory. Colonel Gerks supplemented his presentation with exhibits of d-c aircraft electric-power systems and radio equipment.

Topics for the April meeting were: "D-C Control Systems for Aircraft," and "Effects of Gunfire on Military Aircraft Electric Systems." R. V. White (A '40) field engineer, General Electric Company, Dayton, is secretary of the technical discussion group. T. B. Holliday (M '43) lieutenant colonel, chief of the electrical laboratory, Wright Field, and chairman of the AIEE air transportation committee was one of its originators.

Latest Refinements of Plane Design Described

The electric system of present day bombers has grown into a major part of the design upon which the airplane is dependent for operation and the old system of installing a standard generator and hoping for the best has been discarded for certain methods of evaluation, H. M. Winters (A '40) of The Glenn L. Martin Company's engineering department told members of the Maryland Section at a recent meeting in Baltimore. Mr. Winters presented the paper, "Method of Determining Aircraft Electric Load," in the Section's prize paper contest.

In designing an airplane, Mr. Winters pointed out, it is now necessary to make a load-analysis chart listing each item of electric equipment, the quantity of each item, the operating time, and the number of operations for an average one-hour period. The various conditions under which the items operate including stand-by, starting, take-off, landing, cruising, and taxiing, must be studied. From the detailed and comprehensive data obtained, the demands on the electric system under every possible condition can be deduced to determine the size of the generator needed.

Beaumont Subsection of Houston Section Flourishes

An increase in Institute membership in the area and excellent membership and visitor attendance at its regular monthly meetings are reported by the Beaumont (Tex.) subsection formed in November 1943 under the sponsorship of the officers of the Houston Section. It recently has been proposed that the thriving subsection be the nucleus of a new AIEE Section.

The Beaumont subsection in the extreme eastern part of the Houston Section, where shipbuilding, oil refining, and manufacture of synthetic rubber are the major industries, includes the cities of Port Arthur, Orange, and Beaumont. Since this area lies 90 to 100 miles from Houston, with the imposition of gasoline and tire rationing, travel to Section meetings became difficult. With 23 Institute members thus affected, the Houston Section first experimented with a plan of extended meetings whereby Section meeting programs were repeated the following evening in Beaumont. However, in response to suggestions made at the 1943 AIEE summer meeting in Cleveland, Ohio, the subsection was organized in November 1943.

A motion adopted by the Houston Section defined the purpose of the new subsection: "to permit members belonging to it to attend regular meetings which they would not otherwise be able to do with the meeting place at Houston." The Section agreed to furnish stationery and supplies, to defray other expenses, and, whenever possible, to send its speakers to Beaumont. Local publicity was left to the subsection officers, but all other official Institute matters, publications, and balloting continued under the jurisdiction of the Section. Reports of subsection activities are transmitted to the Section secretary, and the Houston officers endeavor to attend the Beaumont meetings. L. H. Matthes (A '31) resident agent, General Electric Company, Beaumont, was elected subsection chairman and G. W. Morgan (A '37) design electrical engineer, Gulf States Utilities Company, Beaumont, was elected secretary.

Growth of AIEE subsections was encouraged by distribution of a pamphlet from the Sections committee to all Sections during the 1942–43 season. The Sections committee now is studying 15 locations in various Sections where there is a possibility of the successful operation of subsections. At present there are six subsections in operation and two subsections have developed into full Sections.

PERSONAL ●●●●

C. S. Beattie (M '40) formerly manager of engineering, Delta-Star Electric Company, Chicago, Ill., has been appointed vice-president in charge of production and engineering. A 1923 graduate of Rutgers College, Mr. Beattie gained experience as design engineer with the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., the Public Service Production Company, Newark, N. J., and the United Engineers and Constructors, Inc., Newark. As designing engineer he joined the Delta-Star company in 1930. In 1936 he was made assistant sales manager and in 1941 became manager of engineering. **S. C. Killian** (A '42) formerly development and research engineer is now chief engineer of the Delta-Star company. Before entering the University of Michigan in 1930, Mr. Killian worked for the Delta-Star company as draftsman and field engineer from 1923 to 1930. He returned to the employ of the company in 1935 as electrical designer and became research and development engineer in 1941. He is a frequent contributor to technical magazines and a member of Tau Beta Pi. **Manfred Stene** (A '29, M '30) design engineer of the control section, has become electrical engineer. Mr. Stene has been employed by the company since 1924.

Melville Eastham (A '19, M '26) formerly president, General Radio Company, Cambridge, has retired from that position but will continue as a director of the company and for the present will hold the title of chief engineer. Mr. Eastham has been an engineer with the company since 1915. H.

B. Richmond (A '19, F '40) formerly treasurer of the company has been appointed chairman of the board and chairman of the management committee. Mr. Richmond, a 1914 graduate of Massachusetts Institute of Technology, joined the company in 1919. **A. E. Thiessen** (M '41) formerly commercial engineering manager has become vice-president in charge of sales. A 1926 graduate of Johns Hopkins University, Mr. Thiessen was assistant engineer with the Chesapeake and Potomac Telephone Company, Washington, D. C., and member of the technical staff of Bell Telephone Laboratories, Inc., New York, N. Y., before joining the General Radio Company in 1928. He has been commercial engineering manager since 1937.

R. L. Whitney (A '21, M '28) manager of transformer sales, Westinghouse Electric and Manufacturing Company, Sharon, Pa., has been appointed manager of the agency and specialties division of the central district of the company in Pittsburgh, Pa. Mr. Whitney, who first entered the Westinghouse company's power sales department in 1921, has been manager of its Allentown, Pa., office and of its porcelain department in Derry, Pa. **W. W. Sproul, Jr.** (A '42) formerly manager of transformer equipment sales, in Sharon, has been appointed manager of the application department. Mr. Sproul joined the company in 1927 and has been at Sharon in the power transformer sales section and as manager of the equipment section since 1937.

W. G. B. Euler (A '08, M '33) formerly chief engineer, Pacific Coast Gas and Electric Company, San Francisco, Calif., has been appointed vice-president in charge of operations. Mr. Euler was graduated from the University of California in 1905 and was employed by the General Electric Company from 1905 to 1910. In 1910 he joined the Great Western Power Company, San Francisco, and in 1912 was made superintendent of operations. He became general superintendent of the company in 1919. In 1929 when the Pacific Gas and Electric Company absorbed the Great Western company he was made general superintendent of the San Francisco and East Bay divisions of the new company. In 1940 he was appointed chief engineer.

L. J. Moore (A '15, F '42) executive engineer, San Joaquin power division, Pacific Gas and Electric Company, Fresno, Calif., has retired. After three years with the Telluride Power Company, Salt Lake City, Utah, Mr. Moore joined the San Joaquin Light and Power Corporation, Fresno, in 1911 to work on substation maintenance and construction. He became load dispatcher in 1912, engineering assistant to the general superintendent in 1916, electrical engineer in charge of design and construction in 1918, and executive engineer in 1921. Since 1938 when the company was absorbed by the Pacific Gas and Electric Company he has continued as executive engineer of the San Joaquin division.

L. A. Bingham (A '29, M '39) formerly assistant professor in electrical engineering, University of Nebraska, Lincoln, has been appointed associate professor of electrical engineering at the University of Colorado, Boulder. Professor Bingham commenced his teaching career as instructor at Northwestern University, Boston, Mass., from 1924 to 1926. From 1926 to 1929 he was on the staff of the Massachusetts Institute of Technology, Cambridge, and in 1929 was appointed instructor in electrical engineering at the University of Nebraska, becoming assistant professor in 1930. Professor Bingham currently is serving as AIEE vice-president for the North Central District.

C. F. Wagner (A '20, F '40) manager of the central station engineering department of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., recently was honored with the degree of doctor of engineering by the Illinois Institute of Technology for "pioneering research in the application of symmetrical components to power system analyses; for his outstanding contributions to the modern theories of synchronous and induction-machine performance; and for his leadership in the investigation of natural lightning phenomena and the application of knowledge regarding lightning to the protection of electrical systems."

H. E. Strang (A '28, M '39) formerly engineer in the switchgear department, General Electric Company, Philadelphia, Pa., has been named to the staff of the vice-president in charge of engineering design, Schenectady, N. Y. A graduate of Rensselaer Polytechnic Institute, he joined the General Electric Company in 1922. **H. S. Hubbard** (A '23, M '35) of the company's power transformer engineering department, Pittsfield, Mass., has been appointed assistant engineer in the power transformer engineering division and will have charge of design of high-voltage rectifying equipment, testing apparatus, precipitation transformers, and resistance and Sciaky welding transformers.

E. M. Matthews (A '16) engineer, outside plant development department, Bell Telephone Laboratories, Inc., New York, N. Y., has retired. He holds the degrees of bachelor of science (1901) and electrical engineer (1928) from Clemson College. In 1902 Mr. Matthews was employed in the engineering department of the New York Telephone Company, New York, and in 1910 was transferred to the American Telephone and Telegraph Company, New York. In 1919 Mr. Matthews joined the newly formed development and research department and continued with that organization when it was incorporated as Bell Telephone Laboratories in 1925.

R. W. Owens (A '18) formerly general manager of industrial engineering, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., has been made assistant to the president by the Elliott Company, Jeannette, Pa. Mr. Owens, who holds the degrees of bachelor of science and master of science from the University of Illinois, has been connected with the Westinghouse company since 1915. He has held the positions of section engineer, manager of the industrial motor engineering department, general manager of industrial engineering, and manager of the motor division.

Arnold Straussman (A '43) formerly engineer, Long Island Lighting Company, Mineola, N. Y., has become associate editor of *Electric Light and Power* magazine, New York, N. Y. Mr. Straussman has been associated with the power industry since he graduated from Pratt Institute in 1929. With the exception of one year with the Florida Power Corporation, St. Petersburg, he was employed by the Jersey Central Power and Light Company, Sayreville, and Asbury Park, from 1929 to 1940. After a few months with Ebasco Service, Inc., New York, in 1941, he joined the Long Island Lighting Company.

S. H. Mortensen (A '09, F '20) chief electrical engineer, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., recently was awarded the honorary degree of doctor of engineering by the Illinois Institute of Technology for "distinguished leadership in the development of a-c machinery and rectifiers and the extension of their applications; and for his contributions to the design of synchronous-motors and generators and his pioneering research in the development of self-starting synchronous motors and condensers."

W. F. Sims (A '20, F '33) retired chief electrical engineer, Commonwealth Edison Company, Chicago, Ill., recently received the honorary degree of doctor of engineering from the Illinois Institute of Technology for "eminent leadership in the organization, design, and operation of one of the largest electric power generation, transmission, and distribution systems in the world; and for his understanding and stimulation of scientific research in the development and application of equipment for electric power systems."

W. R. Swoish (A '41) formerly vice-president, Roller-Smith Company, Bethlehem, Pa., has been appointed sales manager of the Pennsylvania Transformer Company, Pittsburgh. Mr. Swoish, who was graduated from Ohio State University in 1921, was sales manager of the distribution transformer section and the switchgear division of the Westinghouse Electric and Manufacturing Company, in East Pittsburgh, Pa., and Chicago, Ill., before joining the Roller-Smith Company in 1939.

G. R. Town (A '28, M '37) formerly assistant director of research, Stromberg-Carlson Company, Rochester, N. Y., has been appointed manager of research and engineering. A 1926 graduate of Rensselaer Polytechnic Institute, at which he was instructor from 1933 to 1936, Doctor Town joined the Stromberg-Carlson Company in 1936 as an engineer in the research laboratory. He became engineer in charge of the television laboratory in 1940 and assistant director of research in 1941.

V. A. Sheals (M '39) formerly assistant designing engineer, cable engineering department, General Electric Company, Schenectady, N. Y., has been appointed designing engineer. Associated with the General

Electric company since 1921, Mr. Sheals became a cable engineer in 1923 after completing a student course with the company. In 1930 he was made district cable specialist of the New York, N. Y., office and in 1939 returned to Schenectady as assistant designing engineer.

G. L. Smrz (A '37) formerly vice-president in charge of sales, Line Material Company, Milwaukee, Wis., has been appointed executive vice-president of the company. Born in Milwaukee in 1898, Mr. Smrz joined the Line Material company as manager of the order department in 1919. In 1924 he became secretary-treasurer and general manager of the Line company, East Stroudsburg, Pa. Returning to Milwaukee in 1936 he was made vice-president in charge of sales.

Edward Falck (A '40) formerly deputy director of the Office of War Utilities and recently appointed executive secretary of the Combined Production and Resources Board, has been named director of the OWU. Mr. Falck joined the Office of Production Management in 1941 and has been with the OWU since it was organized. Previously he had been assistant to the vice-president of the Consolidated Edison Company of New York (N. Y.), Inc., and director of research for the Tennessee Valley Authority.

T. F. Peterson (A '25, M '32) formerly director of electric cable engineering and research, American Steel and Wire Company, Cleveland, Ohio, has been appointed manager of the company's newly created electrical sales division. Mr. Peterson has been with the American Steel and Wire Company since 1927 as cable engineer, electrical engineer, director of electric cable works, and since 1941 as director of electric cable engineering and research.

C. L. Keene (A '35, M '38) formerly engineer, mechanical and electrical division, Mutual Boiler Insurance Company, Boston, Mass., has been appointed engineering manager of the company. A 1924 graduate of the Armour Institute of Technology, Mr. Keene served as engineer and supervising engineer for the Ocean Accident and Guarantee Corporation, Ltd., New York, N. Y., before he joined the Mutual company in 1940.

W. D. Coolidge (A '10, M '34) vice-president and director of research, General Electric Company, Schenectady, N. Y., has been awarded one of the two Franklin Medals for 1944 "in recognition of his scientific discoveries, which have profoundly affected the welfare of humanity, especially in the field of the manufacture of ductile tungsten and in the field of improved apparatus for the production and control of X rays."

G. U. Parks (M '30) formerly assistant general manager, Montaup Electric Company, Fall River, Mass., has been made general manager. Mr. Parks was engaged in the electrification of textile mills from 1919 to 1924 and in the latter year joined the Montaup company as system superintendent. He became general superintendent in 1926 and assistant general manager in 1928.

C. A. Hofmeister (A '43) formerly chief electrical engineer Pennsylvania Electric Coil Corporation, Pittsburgh, has been made chief engineer. Born in Pittsburgh in 1909, Mr. Hofmeister received a certificate in electrical engineering from the Carnegie Institute of Technology in 1937. He joined the Pennsylvania Coil company in 1941 as electrical engineer and became chief electrical engineer in 1942.

G. T. Evans (A '27, M '37) formerly assistant chief engineer, the Bristol Company, Waterbury, Conn., has been made manager of production engineering. Mr. Evans entered the employ of the Bristol company in 1928 and after a period in the company's test course, became field engineer in 1930. He was assigned as general staff engineer in 1936 and appointed assistant chief engineer in 1937.

A. D. Robertson (A '39) formerly marine engineer, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., has been appointed assistant manager of the motor division of the company's Norwood, Ohio works. Since he joined the Allis-Chalmers company in 1938, Mr. Robertson has completed the graduate student course in Pittsburgh, Pa., and served as sales engineer in Washington, D. C.

E. J. Herzog (M '43) formerly regional supervisor, Westinghouse Electric International Company, Caracas, Venezuela, has been appointed manager of the company's oil and mining division in New York, N. Y. Mr. Herzog joined the Westinghouse company when he was graduated from the University of Illinois in 1928 and went to Venezuela in 1939.

Roland Whitehurst (A '20, F '43) formerly assistant general sales manager, the Electric Storage Battery Company, Philadelphia, Pa., has been appointed sales manager. Mr. Whitehurst entered the employ of the company in 1908, was manager of its Washington, D. C., branch from 1920 to 1940, and has been assistant sales manager since 1940.

F. G. Logan (A '35) formerly chief development engineer, Ward Leonard Electric Company, Mount Vernon, N. Y., is now manager of development. Mr. Logan joined the company in 1925 as advertising manager, became development engineer in 1929, and was named chief development engineer in 1939.

W. E. Appleton (A '35, M '42) formerly major, Signal Corps, United States Army, now is serving as a lieutenant colonel in Italy.

Wanted: Copies of the January 1944 issue of *Electrical Engineering*. Please mail (parcel post) to American Institute of Electrical Engineers, 33 West 39th Street, New York 18, N. Y., printing your name and address upon the enclosing wrapper. Twenty-five cents plus postage will be paid for each copy returned.

OBITUARY ● ● ● ●

Matthew Orpheus Troy (A '08, M '12) commercial vice-president, General Electric Company, Schenectady, N. Y., died March 13, 1944. Mr. Troy was born December 15, 1872, in Burlington, N. C., and was graduated from the University of Virginia with the degree of bachelor of science in electrical engineering in 1896. After a short employment as superintendent of a small electric railroad, Charlottesville, Va., he joined the General Electric Company, Schenectady, N. Y., in 1897 and later was transferred to Lynn, Mass., where he was made head of transformer testing and special testing. Appointed assistant to the engineer in charge of the general engineering department in 1899, he became commercial engineer in 1900. From 1902 to 1907 he supervised engineering design in general and in 1908 was named assistant head of the transformer commercial department. In 1910 he was appointed manager of sales, and in 1915 was transferred to Pittsfield, Mass., in that position. Returning to Schenectady in 1923 he was appointed executive assistant manager of the central station department, and became manager of the department in 1928, and commercial vice-president in 1937. In 1935 he also was given supervision of central station commercial engineering. He held several patents and was a member of the National League of Masonic Clubs, the Schenectady Chamber of Commerce, Phi Beta Kappa, and Tau Beta Pi.

Charles Frederic Schoonmaker (A '12) chief engineer, H. J. Heinz Company, Pittsburgh, Pa., died February 20, 1944. Born in Albany, N. Y., November 8, 1887, he was graduated from Pratt Institute of Science and Technology in 1909. In 1910 he entered the testing department of the General Electric Company, Schenectady, N. Y., and in 1917 was made food products specialist for the company in Chicago, Ill. From 1917 to 1921 he was assistant engineer for the Quaker Oats Company, Chicago, Ill., and served as executive engineer for the Iowa Railway and Light Company, Cedar Rapids, from 1921 to 1924, and in 1924 was employed by the Central Hudson Gas and Electric Company, Poughkeepsie, N. Y. He became power engineer for the General Engineering and Management Corporation in New York, N. Y., in 1925 and in Charlottesville, Va., in 1926. He joined the Virginia Public Service Company, Charlottesville, as manager of the power department in 1927, becoming manager of the industrial department in 1928. He was appointed manager of the industrial and rate department of the Seaboard Public Service Company, Alexandria, Va., in 1930 and assistant director of sales for the Columbia Gas and Electric Company, Columbus, Ohio, in 1934. In 1943 he was appointed chief engineer of the Heinz company.

Ernest Schattner (A '06, M '18) consulting engineer, London, England, died February 13, 1944. He was born November 10, 1879, in Berlin, Germany, later becoming a British subject and attending Finsbury Technical College. In 1896 he was em-

oyed as technical assistant by the Elec-
ical Power Storage Company, and the ondon Electric Supply Corporation, both London. In 1897 he was technical as- tant for the Norwich Electricity Works. fter his invention of the electricity pre- ayment meter in 1898 he founded the chattner Electricity Meter Company, Ltd. s an independent experimentalist he was nnected with the General Electric Com- any, Schenectady, N. Y., from 1902 to 004 during which time he had several pat- nts issued in his name. Upon his return England he organized the Electrical pparatus Company, Ltd., London, of hich he became chairman. In 1921 he as made director of the former company nd chairman of Electrical Utilities, Ltd., ondon. He was named consulting engi- eer in 1929 and retired in 1931 because of lness.

harles Edward Greene (M '31) consulting ngineer, Cleverdon, Varnay and Pike, Vinchester, Mass., died March 8, 1944. Mr. Greene, who was born in Boston, Mass., February 8, 1889, was graduated rom Massachusetts Institute of Technology vith the degree of bachelor of science in mechanical engineering in 1910. He was mployed by E. B. Badger and Sons Com- any, Boston, in 1911 as assistant super- ntendent of factory and in 1913 was made uperintendent. From 1919 to 1926 he ad charge of design and installation of quipment manufactured by the company. n 1927 he joined Metcalf and Eddy, Con- ulting Engineers, Boston, and since 1937 ad been associated with Cleverdon, Varnay, nd Pike. In 1941 and 1942 he lectured t Smith College and Harvard University. He was awarded the Clemens Herschel prize f the Boston Society of Civil Engineers in 940 and was a member of the American Society of Mechanical Engineers and the New England Water Works Association. Mr. Greene was the author of several tech- ical papers.

Clyde D. Gray (A '02, M '13, F '20) chief lectrical engineer, J. G. White Engineering Corporation, New York, N. Y., died March 9, 1944. Born in Lakeville, N. Y., De- ember 30, 1876, Mr. Gray received from Cornell University the degrees of mechanical ngineer in 1900 and master of mechanical ngineering in 1901. His entire engineering areer was spent in the employ of the J. G. White corporation which he first joined in 901 as engineering assistant. From 1903 o 1905 he engaged in design, estimating, nd correspondence. In 1906 he was made ssistant electrical engineer and in 1908 vas given responsible charge of all electrical vork. He was named assistant electrical ngineer in 1909 and chief electrical engineer n 1912. Mr. Gray was a member of the New York Electrical Society, the American Society for Testing Materials, and the Na- ional Electric Light Association. He served wo terms as president of the village of Pelham, N. Y., was a village trustee for many years, a member of the Board of Edu- ation, and a zoning commissioner.

rederick Herbert Powell (A '08) general manager, Thomas Barlow and Sons, Ltd., Durban, Natal, South Africa, died December 11, 1943. Born September 6, 1883, in Grahamstown, Cape Colony, South Africa, he attended St. Andrew's College and the Transvaal Technical Institute. He was employed as an apprentice by the General Electric Power Company, Ltd., Germiston, Transvaal, South Africa, in 1903, and in 1906 entered the employ of the Crocker Wheeler Company, Ampere, N. J. Returning to South Africa in 1908, he joined the Victoria Falls and Transvaal Power Company, Ltd., Germiston, as assistant construction engineer. He was made acting engineer in charge of the company's compressor station, Fordsburg, Johannesburg, Transvaal, in 1915 and of its Robinson station in 1916. He became resident engineer for the company in 1920. He was associated with Thomas Barlow and Sons first as engineering manager in 1921, was appointed engineering director in 1925 and general manager in 1940.

John Campbell (A '04) consulting engineer, Reading, Mass., died March 6, 1944. He was born in Charlestown, Mass., April 16, 1872. His first electrical work was wiring for the Thomson-Houston Electric Company in 1889. In 1891 he became installation foreman for W. S. Hill and in 1892 operating engineer for the Boston and Maine Railroad. After serving as operating engineer for the United States Navy Department from 1894 to 1901, he established a consulting practice in Chelsea, Mass. He was president and general manager of the Electrical Auditing Company, Boston, Mass., before entering the employ of the Edison Electric Illuminating Company of Boston in 1909 as superintendent of the special service department. Thereafter he remained in that position until he retired from the Boston Edison Company, successor of the Edison Illuminating company, in 1939.

Charles Gardner Winslow (A '02) retired engineer, New York Central Railroad, died n Asheville, N. C., March 9, 1944. Mr. Winslow, who was born August 28, 1871, in Brandon, Vt., was graduated from the University of Vermont with the degrees of bachelor of arts and bachelor of science in electrical engineering. After a brief period as superintendent of construction for the Rochester (Vt.) Electric Light and Power Company and assistant in the office of the engineer, Brooklyn (N. Y.) Rapid Transit Company, Mr. Winslow joined the New York Central Railroad Company about 1904. He was associated with the company first in New York and after 1912 in Detroit, Mich., until he retired in 1938. In 1909 he was connected with Viele, Blackwell, and Buck, New York, N. Y.

John Barnett Edwards (A '29) staff engineer, New York Telephone Company, Brooklyn, died February 5, 1944. Born in Ballinamallard, County Fermanagh, Ireland, January 16, 1898, Mr. Edwards was graduated from St. Luke's College. In 1922 he was employed as engineering assistant by Fothergill Brothers, Exeter, England and from 1923 to 1925 as assistant engineer in the engineering department of the British Post Office, St. Albans, England. Coming to the United States in 1925, he entered the employ of the New York Telephone Company as assistant in the office of the division commercial engineer. In 1928 he was transferred to the plant department where he conducted pre-employment test examinations until 1932. Since 1933 he had been staff engineer.

MEMBERSHIP

Recommended for Transfer

The board of examiners, at its meeting on April 13, 1944, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

To Grade of Fellow

Alexander, T. W., assistant engr., Bell Telephone Co. of Pa., Pittsburgh, Pa.
Carpenter, C. B., asst. chief engr., Pacific Tel. & Tel. Co., Portland, Ore.
Franklin, C. W., elec. engr., Consolidated Edison Co. of N. Y., Inc., New York.
LeFever, O. L., general supt., Northwestern Electric Co., Portland, Ore.
Stephenson, W. B., area engr., Southwestern Bell Tel. Co., Oklahoma City, Okla.
Titus, O. W., chief engr., Canada Wire & Cable Co. Ltd., Toronto, Ont., Canada.
Tompkins, F. N., associate prof. of elec. engg., Brown University, Providence, R. I.

7 to grade of Fellow

To Grade of Member

Baker, E. W., engr., American Tel. & Tel. Co., New York, N. Y.
Breitwieser, C. J., staff engr., Consolidated-Vultee Aircraft Corp., San Diego, Calif.
Brooks, A. F., president, Southern New England Tel. Co., New Haven, Conn.
Brown, P. A., senior elec. engr., Tacoma City Light Dept., Tacoma, Wash.
Eliason, W. L., elec. engr., The Ontario Paper Co. Ltd., Thorold, Ont., Canada.
Enns, W. E., elec. engr., Portland General Electric Co., Portland, Ore.
Gallagher, Charles, chief engr., Engineering Supply Co. of Australia, Ltd., Brisbane, Australia.
Gordy, T. D., elec. engr., General Electric Co., Pittsfield, Mass.
Grant, A. J., associate engr., National Research Council of Canada, Ottawa, Ont.
Gunther, E. T., branch mgr., General Cable Corp., Houston, Tex.
Hagler, J. M., equipment engr., Southwestern Bell Tel. Co., Dallas, Tex.
Klipsch, P. W., head, technical dept., Southwestern Proving Ground, Hope, Ark.
Logan, J. E., relay engr., Jersey Central Power & Light Co., Allenhurst, N. J.
McLean, C. H., asst. chief engr., Automatic Electric Co., Chicago, Ill.
Middleton, W. I., asst. cable engr., Simplex Wire & Cable Co., Cambridge, Mass.
Mundel, A. B., performance supervisor, Sonotone Corp., Elmsford, N. Y.
Nevins, B. R., senior engr., Philadelphia Electric Co., Philadelphia, Pa.
Newcomb, Theodore, engg. dept., Hartford Electric Light Co., Hartford, Conn.
Partridge, K. L., distribution engr., Hartford Electric Light Co., Hartford, Conn.
Plummer, P. V., asst. to general supt. of production, United Illuminating Co., New Haven, Conn.
Rosing, T. F., engr., Cutler-Hammer, Inc., Milwaukee, Wis.
Sedgwick, A. F., elec. engr., United Illuminating Co., New Haven, Conn.
Thring, R. G., asst. supt. of distribution, Capital Transit Co., Washington, D. C.
Weidelich, D. L., asst. prof. of elec. engg., University of Missouri, Columbia, Mo.
Webber, F. G., research engr., F. W. Sickles Co., Chicopee, Mass.
Werner, H. G., design engr., Department of Public Works, Philadelphia, Pa.
Woodman, F. W., elec. engr., Ontario-Minnesota Pulp and Paper Co., Ltd., Fort Frances and Kenora, Ont., Canada.

27 to grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Names of applicants in the United States and Canada are arranged by geographical District. Any member objecting to the election of any of these candidates should so inform the national secre-

tary before May 31, 1944, or July 31, 1944, if the applicant resides outside of the United States or Canada.

To Grade of Member

Adams, M. D., West. Union Tel. Co., New York, N. Y.
Allen, S. B., Allied Control Co., Inc., New York, N. Y.
Anderson, L. E., Columbus Trans. Co., Columbus, Ga.
Arnold, S. T., Boston Edison Co., Boston, Mass.
Avila, C. F., Boston Edison Co., Boston, Mass.
Bascetta, A., B & S Corrugated Paper Mchy. Co., Inc., Brooklyn, N. Y.
Beavers, F. J. (Reelection), Scranton Electric Co., Scranton, Pa.
Berman, A., Imperial Chem. Ind., Ltd., Northwich, England.
Blickley, C. E., Rural Elect. Adm., St. Louis, Mo.
Boucher, C. E., Industrial X-Ray Engrs., Portland, Oreg.
Bray, F. J., Edward J. White Co., Newark, N. J.
Brehme, F., U. S. Treasury Dept., Washington, D. C.
Burke, A. G. (Reelection), Burke Elec. & X-Ray Co., Ltd., Toronto, Ont., Can.
Chappell, H. D., Burroughs Adding Mach. Co., Detroit, Mich.
Cheney, O. V., Chrysler Corp., Detroit, Mich.
Coates, R. H., Sheffield Corp., Sheffield, England.
Colbath, H. S., Bibb Mfg. Co., Macon, Ga.
Collier, H. D. (Reelection), Sanderson & Porter, Inc., New York, N. Y.
Correy, S. W., Pub. Serv. Co., Tulsa, Okla.
Crocker, C. R., Otis Elevator Co., Atlanta, Ga.
Dangerfield, H., Rural Elect. Adm., St. Louis, Mo.
Darling, A. G. (Reelection), Gen. Elec. Co., Schenectady, N. Y.
Davis, C. F., U. S. Navy Dept., Portland, Oreg.
Deubel, J. A., Perfex Corp., Milwaukee, Wis.
Downs, G. W., Calif. Inst. of Tech., Pasadena, Calif.
Genachte, P. F. (Reelection), Mexican Lt. & Pr. Co., Ltd., Mexico, D. F., Mex.
Ghignatti, G., Chattanooga Elec. Pr. Bd., Chattanooga, Tenn.
Happ, E. L., Ecusta Paper Corp., Pisgah Forest, N. C.
Hayden, J. R., Intl. Stacey Corp., Columbus, Ohio
Hill, M. F., Texas-Empire Pipe Line Co., Tulsa, Okla.
Howard, H. P., Jr., Chesapeake & Potomac Tel. Co., Washington, D. C.
Johnson, E. L. (Reelection), Long Island Lighting Co., Roslyn, N. Y.
Johnson, F. O., Gen. Motors Corp., Detroit, Mich.
Madsen, C. J., West. E. & M. Co., East Pittsburgh, Pa.
Magee, C. F., E. I. du Pont de Nemours & Co., Wilmington, Del.
Miller, E. G., Allied Control Co., New York, N. Y.
Mills, O. H., Jr., Southwestern Bell Tel. & Tel. Co., Atlanta, Ga.
Montgomery, O. D., West. E. & M. Co., East Pittsburgh, Pa.
Moseley, C. W., R. H. Bouligny, Inc., Charlotte, N. C.
Nelson, N. (Reelection), E. I. du Pont de Nemours & Co., Wilmington, Del.
Pearson, M. E., Rural Elect. Adm., St. Louis, Mo.
Phillips, J. L., J. M. Clayton Co., Atlanta, Ga.
Reap, F. D., Gen. Elec. Co., Pittsburgh, Pa.
Ross, G. F., Koppers United Co., Monaca, Pa.
Rushlow, W. E., Rural Elect. Adm., St. Louis, Mo.
Scott, J. P. (Reelection), Bell Tel. Co. of Pa., Pittsburgh, Pa.
Self, P. N. Cockatoo Docks & Eng. Co., Sydney, Aust.
Sellers, A. A., Koppers United Co., Monaca, Pa.
Sigsby, J. E., N. J. Bell Tel. Co., Newark, N. J.
Smith, D. O. (Reelection), Georgia Pr. Co., Atlanta, Ga.
Smith, M. W., Ohio Edison Co., Akron, Ohio
Stahl, G. D. (Reelection), E. B. Badger & Sons Co., Boston, Mass.
Stebbins, F. G., General Elec. Co., Pittsfield, Mass.
Sywulka, V. S. (Reelection), Cutler-Hammer, Inc., Milwaukee, Wis.
Tessohn, M. (Reelection), Amer. Gas & Elec. Serv. Corp., New York, N. Y.
Torrence, J. R., Tenn. Valley Auth., Knoxville, Tenn.
Trumbull, A. F., Aeronautical Radio, Inc., Washington, D. C.
Tubbs, L. G. (Reelection), West. E. & M. Co., East Pittsburgh, Pa.
Wakefield, S. J., Assoc. Res., Inc., Chicago, Ill.
White, K. D., White Elec. Const. Co., Atlanta, Ga.
Williams, C. R., West Point Mfg. Co., West Point, Ga.
Willoughby, F. W. (Reelection), E. I. du Pont de Nemours & Co., Wilmington, Del.

62 to grade of Member

To Grade of Associate

United States and Canada

1. North Eastern

Albright, J. W., Gen. Elec. Co., Pittsfield, Mass.
Asmuth, J. L., M.I.T., Cambridge, Mass.
Devine, M. E. C., West. E. & M. Co., New Haven, Conn.
Erickson, E. A., Lieut., U.S.N.R., Syracuse, N. Y.
Eskins, W. E., West. E. & M. Co., Boston, Mass.
Eyles, E. G., General Elec. Co., Fitchburg, Mass.
Gildersleeve, T. S. (Reelection), Gen. Cable Corp., Boston, Mass.
Hall, T. W., Gen. Elec. Co., Pittsfield, Mass.
Ingram, G. H., Gen. Elec. Co., Syracuse, N. Y.
Kell, R. E., Harvard Univ., Cambridge, Mass.
Krum, C., Cent. Hud. Gas & Elec. Corp., Poughkeepsie, N. Y.
Macphearson, J. F., Gen. Elec. Co., Lynn, Mass.
Mansur, R. L., West. E. & M. Co., Boston, Mass.
Miller, G. A., Post & Lester Co., Hartford, Conn.
Nickels, J. M., Gen. Elec. Co., Schenectady, N. Y.
Peterson, J., Gen. Elec. Co., Lynn, Mass.
Prince, L. W., Bethlehem Steel Co., Boston, Mass.
Rice, B. S., Niag. Hudson System, Buffalo, N. Y.
Simmons, H. O., Jr., Gen. Elec. Co., Lynn, Mass.
Southwell, L. H., West. E. & M. Co., South Boston, Mass.
Sprague, M. B., So. New Eng. Tel. Co., New Haven, Conn.
Taber, J. H., Int'l. Bus. Mach., Rochester, N. Y.

2. Middle Eastern

Alderson, W. S., Ensign, U.S.N.R., Washington, D. C.
Benes, E. W., Arthur G. McKee & Co., Cleveland, Ohio
Bogart, L. J., Naval Ord. Lab., Washington, D. C.
Carroll, B. E., Glenn L. Martin Co., Baltimore, Md.
Cheshire, W. E., Cincinnati Gas & Elec. Co., Cincinnati, Ohio
Delmege, A. H., Ensign, U.S.N.R., Washington, D. C.
Gittings, W. N. (Reelection), Gen. Elec. Co., Philadelphia, Pa.
Grantham, J. O., Naval Res. Lab., Washington, D. C.
Jay, J. H., Wright Field, Dayton, Ohio
Kindt, F. T., U. S. Navy Yard, Phila., Pa.
Lee, R., West. E. & M. Co., Baltimore, Md.
Mead, O. J., Naval Res. Lab., Washington, D. C.
Myers, S. D., U. S. Army, Akron, Ohio
Norton, J. M., Naval Ord. Lab., Washington, D. C.
Pearson, E. E., Leeds & Northrup Co., Philadelphia, Pa.
Peters, C. C., Captain, U. S. Army, Washington, D. C.
Robenalt, W. T., Hazel Atlas Glass Co., Zanesville, Ohio
Roberts, N. J., Ohio Pub. Serv. Co., Warren, Ohio
Rose, D. J., Firestone Tire & Rubber Co., Akron, Ohio
Schenck, P. C., U. S. Engineers, Dayton, Ohio
Smith, F. G., Jr., Naval Res. Lab., Washington, D. C.
Steinlauf, B., City Eng. Co., Dayton, Ohio
Taylor, C. L., Jr., Keebler Weyl Baking Co., Philadelphia, Pa.
Wagner, M. J., Kelso-Wagner Co., Dayton, Ohio
Whalen, W. T., Alum. Co. of America, Burlington, N. J.
Wilson, R. T., West. E. & M. Co., Lester, Pa.
Woloszynek, B. M., Linderme Tube Co., Cleveland, Ohio
Wright, H. N., Naval Ord. Lab., Washington, D. C.

3. New York City

Anderson, L. H., Heyden Chem. Corp., Fords, N. J.
Beck, W. S., Westinghouse Elec. Int'l Co., New York, N. Y.
Beckmeyer, J. W., Fed. Tel. & Radio Corp., East Newark, N. J.
Brand, A. C., Cox & Stevens, Inc., New York, N. Y.
Brown, H. J., Penna. R.R. Co., New York, N. Y.
Buchwald, H., West. Union Tel. Co., New York, N. Y.
Cambria, W., Brewster Aero. Corp., Long Island City, N. Y.
Cannon, J. F., Bell Tel. Labs., New York, N. Y.
Convery, J. F., Jr., Gibbs & Cox, Inc., New York, N. Y.
Cozzie, J. A., U. S. Navy Yard, Brooklyn, N. Y.
Furman, S. P., U. S. Navy Yard, Brooklyn, N. Y.
Gardner, W. E., Fed. Tel. & Radio Corp., Newark, N. J.
Hoagland, K. A., Allen B. DuMont Labs., Inc., Passaic, N. J.
Minc, A., Columbia Univ., New York, N. Y.
Morrison, W. J., Prudential Ins. Co., Newark, N. J.
Nagata, B. Y., Fed. Tel. & Radio Corp., East Newark, N. J.
Reed, R. A., Fed. Tel. & Radio Corp., East Newark, N. J.
Rouquette, H. P., U. S. Navy Yard, Brooklyn, N. Y.
Smith, G. V. (Reelection), Fed. Tel. & Radio Corp., Newark, N. J.
Sparkman, J. J., Westinghouse Int'l Co., New York, N. Y.
Stone, C. E., Jr., Bell Tel. Labs., Inc., New York, N. Y.
Voss, C. W., Givaudan-Delawanna, Inc., Clifton, N. J.
Wafiner, W. J., W. L. Maxson Corp., New York, N. Y.

4. Southern

Byck, S. M., Byck Elec. Co., Inc., Savannah, Ga.
Camus, F. G., City of Shreveport, Shreveport, La.
Cunningham, J. W., Clinton Engr. Works, Oak Ridge, Tenn.
Dycus, H., Knoxville Electric Pr. & Water Bd., Knoxville, Tenn.
Fishburn, R. E., Royal Indemnity Co., Atlanta, Ga.
Francisco, C. E., Carroll County Elec. Dept., McKenzie, Tenn.
Gostin, B. F. (Reelection), Tenn. Valley Auth., Chattanooga, Tenn.
Harden, W. F., Georgia Pr. Co., Columbus, Ga.
Hine, R. T., Tenn. Eastman Corp., Kingsport, Tenn.
Jones, P. F., Jr., Georgia Pr. Co., Atlanta, Ga.
Long, J. T., Clemson College, Clemson, S. C.
Martin, B. H., Tenn. Valley Auth., Chattanooga, Tenn.
May, W. O., Light Gas & Water Div., Memphis, Tenn.
Morrison, R. S., West. E. & M. Co., Birmingham, Ala.
Moyer, G. E., Elec. Const., Inc., Pascagoula, Miss.
Ness, J. G., Eckardt-Ness Electric Co., Atlanta, Ga.
Pollock, W. J., Jr., Tenn. Eastman Corp., Oak Ridge, Tenn.
Raney, J. R., Georgia Pr. Co., Atlanta, Ga.
Schimmel, H. C., Hickman Fulton Rural Elec. Co-op., Hickman, Ky.
Weaver, C. H., Tenn. Eastman Corp., Oak Ridge, Tenn.

5. Great Lakes

Barnes, H. A., City Police Div., Flint, Mich.
Bergrun, T., Midland Elec. Coal Corp., Farmington, Ill.
Boesenwetter, C. C., Goodman Mfg. Co., Chicago, Ill.
Bollinger, W. H., Esterline-Angus Co., Indianapolis, Ind.
Brown, R. P., Delta-Star Elec. Co., Chicago, Ill.
Buckley, A. W., White City Elec. Co., Chicago, Ill.
Clodfelter, N., American Tel. & Tel. Co., Indianapolis, Ind.
Corrigan, R. E., Dodge, Chicago Plant, Chicago, Ill.
Crumpton, J. T., Amer. Tel. & Tel. Co., Indianapolis, Ind.
Dischinger, I. E., Jr., Aluminum Co. of America, Brookfield, Ill.
Dolinko, L., Illinois Inst. of Tech., Chicago, Ill.
Easterday, V. I., Northern Ind. Pub. Serv. Co., Hammond, Ind.
Ewald, S. J., Jr., American Tel. & Tel. Co., Chicago, Ill.
Gall, J., Esterline-Angus Co., Inc., Indianapolis, Ind.
Gould, H. A., Dodge Chicago Plant, Chicago, Ill.
Grennan, C. E., Dodge Chicago Plant, Chicago, Ill.
Koch, L., Chrysler Corp., Chicago, Ill.
Koenig, M. F., Cutler-Hammer, Inc., Milwaukee, Wis.
Martin, J. E., Dodge Chicago Plant, Chicago, Ill.
McCarvell, J., Emerson Comstock, Chicago, Ill.
Meining, R., ExCello Corp., Detroit, Mich.
Moore, B. T., Gen. Elec. Co., Chicago, Ill.
Petersen, V. R., Gen. Elec. Co., Fort Wayne, Ind.
Schwartzburg, W. E., Allis-Chalmers Mfg. Co., West Allis, Wis.
Sears, J. W., Ind. Bell Tel. Co., Indianapolis, Ind.
Seidenfeld, B. A., Dodge Chicago Plant, Chicago, Ill.
Spankie, T. S., Dodge Chicago Plant, Chicago, Ill.
Thompson, D. L., Northern Ind. Pub. Serv. Co., Hammond, Ind.
Tracht, P. A., Evans Prods. Co., Detroit, Mich.
Troup, R. J., Northern Ind. Pub. Serv. Co., Hammond, Ind.
Walters, R. E., Allen-Bradley Co., Milwaukee, Wis.
Wessel, R. A., Dodge Chicago Plant, Chicago, Ill.
Wolff, A. J., Dodge Chicago Plant, Chicago, Ill.

6. North Central

Cross, W. D., Univ. of Colo., Boulder, Colo.

7. South West

Cox, W. H., Consolidated Steel Corp., Ltd., Orange, Texas
Croy, R. J., Pratt & Whitney Aircraft Corp., Kansas City, Mo.
Floyd, C. B., Southwestern Prov. Ground, Hope, Ark.
Green, C. A., Curtiss-Wright Corp., St. Louis, Mo.
Holden, H., Jr., Southwestern Bell Tel. Co., Houston, Texas
Horak, R. K., Curtiss-Wright Corp., St. Louis, Mo.
Merchant, M. W., Rural Elec. Adm., Abilene, Texas
Sandford, E. O., Jr., Sandford Const. Co., Oklahoma City, Okla.
Wooldridge, K., E., Alum. Ore Co., Bauxite, Ark.

8. Pacific

Beren, W. J., Capitol Elec. Co., San Diego, Calif.
Bertrand, D. C., Gen. Elec. Supply Corp., San Diego, Calif.
Brackett, P. E., Line Material Co., Los Angeles, Calif.
Chapman, H. B., Electrical Contractor, Los Angeles, Calif.
Dusenbery, H. S. (Reelection), Moore Dry Dock Co., Oakland, Calif.
Gooder, P. O., Fischbach & Moore, Inc., Richmond, Calif.
Herstedt, A. H., U. S. Navy Yard, Mare Island, Calif.
Kenworth, W., Littlefuse, Inc., El Monte, Calif.
Kilman, L. B., Jr., Hughes Aircraft Co., Los Angeles, Calif.
Larimore, E. A., Douglas Aircraft, Inc., Santa Monica, Calif.
Leach, F. C., Dept. of Water & Pr., Los Angeles, Calif.
Ryals, C. A., Jr., Ensign, U.S.N.R., San Francisco, Calif.
Schultz, E. B. (Reelection), Lockheed Aircraft Corp., Burbank, Calif.
Skow, H. N., West. E. & M. Co., San Francisco, Calif.
Thedaker, G. R., Jr., Public Serv. Dept., Burbank, Calif.

9. North West

Boyd, H. L., Jr., Lieut., U. S. Army, Seaattle, Wash.
Fox, J. D., Alum. Co. of America, Trentwood, Wash.
Groth, S., U. S. Engineers, Portland, Oreg.
Mitchum, C. D., Associated Shipbuilding Corp., Seattle, Wash.
Short, H. A., J. J. Agutter & Co., Seattle, Wash.
Stobie, J., Wash. Water Pr. Corp., Spokane, Wash.

10. Canada

Elliott, A. H., Can. West. Co., Ltd., Hamilton, Ont., Can.
Ham, J. M., Univ. of Toronto, Toronto, Ont., Can.

Elsewhere

Alfaro, G. B., Mexican Lt. & Pr. Co., Mexico, D. F., Mex.
Beach, J. E., Trinidad Leaseholds, Ltd., Trinidad, B. W. I.
Clark, L. J., British Thomson-Houston Co., Ltd., Rugby, England
Espriella Miranda, F., Mexican Lt. & Pr. Co., Ltd., Mexico, D. F., Mex.
Gomez, R. N., Mexican Lt. & Pr. Co., Ltd., Mexico, D. F., Mex.
Higgins, B. G., British Thomson-Houston Co., Ltd., Rugby, England
Medinillo Valencia, E., Mexican Lt. & Pr. Co., Ltd., Mexico, D. F., Mex.
Pamnani, L. C., Fazilka Elec. Supply Co., Ltd., Fazilka, Punjab, India
Villada, J. N., Oetroleos Mexicanos, Mexico, D. F., Mex.
Wheatley, M., Mexican Lt. & Pr. Co., Ltd., Mexico, D. F., Mex.

Total to grade of Associate

United States and Canada 159

Elsewhere 10

ritish–American Pact Lifts Patent Restrictions

The pooling of scientific and technical in- rmation and of patent rights accomplished means of the British–American Patent iterchange Agreement effective January 1, 942, particularly has benefited aircraft, dio, and ordnance production according a recent statement of the War Department.

Confined to the manufacturing of prod- cts required in winning the war, the agree- ent grants American manufacturers free censes to use British-owned patents and ex- nds the same privileges to British manufac- irers who wish to employ American-owned atented devices or ideas. According to the greement processes, technical information, rawings, designs, and patent rights owned y the manufacturers of one nation are eleased to the other. At the end of the war atent rights will revert to their respective wners, and property interests in the postwar se of all kinds of industrial information are eing safeguarded by provisions of the Lend- ease Act.

Among the products being manufactured both the United Kingdom and the United tates under the terms of the agreement are: kite which carries aloft an aerial for radio- ng distress signals; air compressors; range nders; illuminated gun sights; turrets; ises; incendiary bombs; air-borne life- oats; lathes; bomb releases; catalysts; orpedoes; condenser tubes; warship pro- ellers; periscopes; bearings; and lac- uers. Many of the products affected may ot be publicized during the war.

Government contractors wishing to exer- ise these wartime rights should file a re- uest through the contracting officer or chnical representative of the agency with hich they have war contracts. A requisition prepared by the agency and forwarded to ne British representatives. Inasmuch as ne British Government has broad powers nder the Patents and Designs Act, the infor- iation and licenses can be forwarded romptly. Regulations under which lend- ase aid can be obtained from the United ingdom and several other Allies are set rth in War Department procurement regu- tions and Navy procurement directives. opies of the Patent Interchange Agreement nd other lend-lease and reciprocal-aid greements will be supplied upon request y the State Department, Washington 25, . C.

Var Safety Tests Lead Year's Work at Underwriters' Laboratories

The current work of Underwriters' Labo- atories, Inc., to reduce fires, accidents, nd crime, and reports of the activities of ne various engineering departments for 943 took precedence over celebration of ne organization's 50th anniversary at the nnual dinner meeting, April 6 in Chicago, l. John C. Harding, chairman of the oard of trustees, presided.

President Alvah Small (M '37) recalled briefly the history of the development of the Laboratories and then outlined the high-spots of the year's achievements. Besides their great contributions to the war effort he noted a growing number of conferences with manufacturers indicating increased activity in postwar planning for the production of civilian goods. Included in the reports of the departmental laboratories' heads were some of interest to electrical engineers.

Robert B. Shepard (F '36), chief electrical engineer, whose headquarters are at the New York City, N. Y., testing station, reported that the critical status of steel, copper, zinc, and rubber had made necessary the testing of many new designs of electrical equipment. A variety of new synthetic insulations for electric wires has been investigated, some of which have revealed properties superior to those of natural rubber, he stated.

The shortage of steel for construction has given an impetus to the development of new methods of flameproofing lumber, and several surface-treatment and impregnation methods have been found effective, according to Albert J. Steiner, engineer of the fire-protection department. Another new development is in nonmetallic heating and air-conditioning ducts. Tests show that certain of these are so constructed that they provide adequate insulation and strength and do not introduce a fire hazard.

Earl J. Smith, engineer of the gases and oil department, reported that many tests had been conducted on oil fired heating and power equipment and on acetylene generators for war projects.

R. W. Hendricks, hydraulic engineer, loaned to the United States Rubber Reserve Company to direct an investigation at Baytown, Tex., told of large-scale tests run there to determine ways of protecting butadiene and styrene storage tanks against fire. Fifty to 125 gallons of gasoline a minute were allowed to burn for several hours at a time in order to study the prevention and control of these fire explosions.

H. C. Conick, United States manager of Royal Insurance Company, Ltd., New York, N. Y., was the only new trustee elected at the annual meeting.

Army Training Reserve to Be Operating by July 1

Approximately 150,000 from an estimated 200,000 young men who will be graduated from high school in June 1944 took the qualifying examination for admittance to the Army Specialized Training Reserve, substitute for the Army Specialized Training Program which was curtailed because of military necessity.

The new program, which has been expanded to concur with the suggestions of the American Council on Education's committee on the relationships of higher education to the Federal Government, admits high school graduates between the ages of 17 years and 17 years and nine months and a limited number between 17 years and nine months and 22 years of age who have completed basic military training. Men between 17 and 19 years of age, inclusive, who are high school graduates by July 1, 1944, may express a preference for the V-12 program of the Navy.

Those who are accepted from the first age group are assured of a minimum of nine months of college work, and the cost of tuition, fees, food, housing, and medical care will be paid by the Government. Men will be assigned to curricula in applied sciences; chemical, and biological sciences preparatory to medical and dental studies; and mathematics and physics. These curricula are similar to previous ASTP curricula.

Many details concerning the assignment of applicants to particular colleges and universities, the duration of the program for various age groups, and specific curricula available will be worked out before July 1.

Technical Advisory Committee Classifies Alien Patents

The technical advisory service recently set up within the Smaller War Plants Corporation (*EE, Nov '43, p 512*) has undertaken to sift from the 45,000 foreign patents vested in the Alien Property Custodian, those potentially most valuable to small manufacturers. The patents selected will be analyzed by science advisory committees and the most promising subjected to further study. Bulletins listing and classifying the final selections will be made available to small manufacturers through the Corporation's offices.

Patents which were not exclusively licensed to American firms or citizens before seizure of the patents by the Government are available immediately to those interested. Licenses on enemy patents are nonexclusive, nonassignable, and royalty-free, and the license applications fee is $15 per patent. Small plants will be notified of the date of the bulletins publication. Meanwhile a detailed catalogue of all vested patents may be consulted in each of the regional and field offices of the Smaller War Plants Corporation.

Aircraft Electrical Council Formed by NEMA. A subdivision of the National Electrical Manufacturers Association, the Aircraft Electrical Council, which will function as a liason group between the aircraft and electrical manufacturing industries was organized with 50 member companies at the spring meeting of the NEMA in Chicago, Ill. The Council will make available the experience and facilities of electrical manufacturers to producers of aircraft and representatives of the armed services confronted with aviation problems. Member companies will be provided with information abou performance and production requirements of electric equipment for aircraft applications, and per-

tinent purchase specifications will be developed. The aircraft industry and its affiliated professional and technical organizations may consult with the Council on any of its problems pertaining to the development and procurement of electrical products. The Council's offices are at 155 East 44th Street, New York 17, N. Y.

Device Saves Drafting Time and Materials. Primarily to offset the shortage of draftsmen, a device for judging whether a completed drawing will reproduce satisfactorily, known as the Legimeter, has been developed by D. J. Wishart of The Glenn L. Martin Company, Baltimore, Md. The device is a two-panel illuminated table. In one panel are sample drawings from which satisfactory prints have been made. The second panel is a sheet of ground glass on which the draftsman can place the drawing to be evaluated. With both panels illuminated by light of the same intensity, a moment's scrutiny will reveal whether the lines of the drawing are heavy enough for satisfactory reproduction.

ANEPA to Be Disbanded. Because of changes in the electronics production program and the functions of the field services of the Army, Navy, and War Production Board, the Army–Navy Electronics Production Agency will be dissolved within the next 60 or 90 days. Its duties and staff will be distributed between the Signal Corps procurement division, the Navy Bureau of Ships, and the WPB radio and radar division. Some of the ANEPA headquarters and field staff will be transferred to the other agencies.

POSTWAR • • • • •

CED Handbook on Postwar Outlook for Business Issued

"Planning the Future of Your Business," a handbook prepared for the Committee for Economic Development by a special committee of the Association of Consulting Management Engineers, has been issued by CED headquarters in New York, N. Y. The handbook, which can be obtained only through the local Committees for Economic Development now organized in approximately 1,408 communities throughout the United States, offers concrete suggestions that may be adopted by industrial employers in planning their postwar production and employment programs. In brief, these are:

1. To define and allocate responsibility for postwar planning.
2. To plan respective product programs.
3. To plan corresponding market and sales programs.
4. To determine the manufacturing facilities required.
5. To estimate employment requirements, define jobs, and plan employee training.
6. To estimate the operating funds needed and to plan their sources.

The Committee for Economic Development is a nonprofit organization established to assist, within communities, company-by-company planning for new high levels of production, employment, and distribution in the postwar period. It is self-supporting, being financed entirely by contributions from private business. Eighteen trustees, 12 regional chairmen, and approximately 100 district chairmen comprise its administrative board and determine its national policies. The idea of establishing the Committee originated when Secretary of Commerce Jesse Jones called together a group of business men in 1942; as formally organized a year later, it is independent of Government subsidy and control, but has been assured co-operation by governmental agencies as well as by great national business organizations.

Basic responsibility for the Committee's activities rests with its board of trustees, under the chairmanship of Paul G. Hoffman, president, The Studebaker Corporation, South Bend, Ind. Its efforts are carried out through two major divisions—the field development division and the research division.

The field development division, headed by Marion Folsom, treasurer of Eastman Kodak Company, Rochester, N. Y., is responsible for stimulating, encouraging, and helping individual enterprises to plan their product and marketing programs for the postwar periods. Its efforts are directed at reaching and influencing the many smaller businesses and the limited group of large employers equally. Assisting the division is an industrial advisory board, composed of men highly trained in the knowledge of the development of new materials and new technologies, under the chairmanship of David C. Prince (F '26) vice-president in charge of application engineering, General Electric Company, Schenectady, N. Y.

The research division, under the chairmanship of Ralph Flanders, president of Jones and Lamson Machine Company, Springfield, Vt., is engaged in studies, national in scope, concerned with the practical problems of reconversion to civilian production and with the defining of conditions necessary to encourage progressive growth of business enterprise in the postwar period. The studies are undertaken by a research committee of business men who are advised by a board of outstanding economists and social scientists. Professor Sumner Slichter, Lamont professor of economics, Harvard University, Cambridge, Mass., presides over the board, assisted by Robert DeB. Calkins, Dean of the School of Business, Columbia University, New York, N. Y. Professor Theodore Yntema, professor of economics on leave from the University of Chicago, Ill., is engaged as full-time research director.

Association for an International Office for Education Formed

Formation of the American Association for an International Office for Education, under the chairmanship of Doctor Harlow Shapley, Harvard College Observatory, was announced recently. Comprised of nationally known educators, industrialists, church leaders, labor leaders, and authors, the association is working to enlist the support of the American public in the establishment of such an internationally recognized office, which will insure that education be given proper ranking with political organization, police, distribution of raw materials, stabilization of currencies, and improving of health conditions in postwar planning programs.

Among the educational and intercultural benefits that an international education office can effect are the recommendation of minimum standards at all educational levels; supervision of the distribution of funds to repair devastated school systems and universities, if the United Nations determine upon a policy of relief and rehabilitation of schools; assistance to the nations through adult education to meet the problems of adjusting demobilized armed forces and people in war industries, and in the resettlement of refugees; establishment of a center for the exchange of experiences and techniques in the field of education and cultural relations; facilitation of the international exchange of students, professors, scientists, and artists; and establishment of schools for administrators and teachers to train personnel for those countries which, after the war, will be staffed inadequately and which, at first, will not be able to provide such facilities themselves.

Projected Station at Olney to Lead Postwar FM Broadcasting Research

Application for the licensing of a unique type of FM broadcasting station to be located in the Washington, D. C., area has been filed with the Federal Communications Commission in the name of the FM Development Foundation. Organized by Edwin H. Armstrong, inventor of the FM system, and by C. M. Jansky, Jr. (M '32) and Stuart L. Bailey, members of the consulting engineering firm of Jansky and Bailey, Washington, who constructed the first FM station in that city, the Foundation will carry on research and experimentation to foster the development of the FM broadcasting art.

The removal of the FCC's ban on newspaper ownership of stations, and the gradual realization by various educational groups and institutions of the possibilities opened up by this new method of broadcasting has produced an enormous quantity of applications for licenses that are beyond the resources of the short-handed Washington engineering firms to handle. With the granting of these applications and the widespread postwar propagation of FM stations throughout the United States, many new problems of allocation and operation will arise, which the Foundation has set itself to solve.

Proposed site for the station is Olney, Md., because of its convenience to the Jansky and Bailey laboratories, which will supervise the tests, and because its service over the capital area and surrounding territory of approximately 20,000 square miles will be an effective demonstration of the possibilities of of the system. The transmitting equipment will be substantially a duplicate of Professor Armstrong's original staticless station at Alpine, N. J. Construction of the station, a project estimated at six to nine months, is pending favorable action by the Commission and the end of the war.

RMA Studies Postwar Employment and Contract Termination. An industry survey on postwar employment recently was authorized by the board of directors of the Radio Manufacturers Association. From the brief questionnaire which will be forwarded to manufacturers shortly, estimates on postwar employment, for both present and new employees, will be developed. Statistics on both men and women workers who probably will retain their present positions and also on former employees now in the armed services is desired. Comparative data for 1940 will be used in arranging the material received. A subcommittee to present RMA recommendations on termination procedure to government officials has been appointed by the contract terminations committee which has endorsed the horizontal company settlements plan devised by the Baruch agency. Members of the subcommittee are R. F. Sparrow, J. P. Rogers, L. W. Adkins, M. F. Balcom, and R. C. Sprague.

Bacon Foresees Unparalleled Postwar Prosperity. "Postwar prosperity in the United States, if not the world, will far exceed, during its first quarter of a century, any business activity for a like period the world has ever witnessed," in the opinion of G. W. Bacon, chairman of the board and a founder of Ford, Bacon, and Davis, Inc., New York, N. Y. Speaking at the 50th anniversary celebration of his company recently, Mr. Bacon outlined the probable industrial trends of the next 50 years and reviewed the history of the engineering firm he had helped found. A commemorative medal was presented to Mr. Bacon by James F. Towers, president of the firm on behalf of his associates. Mr. Bacon expects stimulation for postwar prosperity to come from the almost total depletion of normal inventories. New markets will result "from existing and expanding incomes, living standards and credit facilities," he said. He valued postwar production and distribution at tens of billions of dollars and predicted "credit facilities such as our people have never known" to supply the vast sums for replenishing "present enormous volumes of depreciated facilities and equipment of all kinds in the United States and beyond our borders." Mr. Bacon maintained that the primary task of the industrial world for the next half century would be to insure raw material bases natural and synthetic, continuing to meet the world's requirements.

INDUSTRY • • • • •

40 Per Cent Decline in Industrial Accidents Is Goal for 1944

One million fewer work accidents in the next 12 months is the goal set by Secretary of Labor Frances Perkins for attainment by American labor and management, according to Verne A. Zimmer, director of labor standards, United States Department of Labor.

The new goal would be a 40 per cent decline from the 2,500,000 industrial accidents that occurred in 1943—the highest total in history, Mr. Zimmer explained. Analyzing the statistics further he pointed out that 18,400 workers had been killed, 1,700 more had been totally and permanently disabled, 108,000 others had been permanently crippled, and that accidents temporarily had removed from service 2,225,000 workers for an average of 15 days apiece.

In the past three years, to reduce the number of accidents in industry 600 top-flight safety engineers, recruited by the Department of Labor on a voluntary basis, have brought safety service directly into 25,000 war-contract plants. Of the firms accepting this service, 75 per cent have reduced their accident frequency materially, and many of the plants report one, two, or three years without a single lost-time injury.

In addition to this Government aid the Department of Labor and the Office of Education have been sponsoring safety-training courses for labor in which 50,000 plant foremen and leadmen already have received practical instructions on how to make a plant accident-free. Detailed information concerning these special training courses for labor groups can be obtained by writing to the division of labor standards, United States Department of Labor.

Railroads and Telegraph Companies to Honor Morse

The 100th anniversary of the sending of the first telegraph message, "What hath God wrought!" by Samuel Morse is being observed on May 24 by the telegraph industry and the Association of American Railroads with the re-enactment in Washington, D. C., and Baltimore, Md., of the first ceremony.

The original message was flashed over the first telegraph line from the chamber of the United States Supreme Court, then in the Capitol in Washington, to the Baltimore and Ohio Railroad station in Baltimore on May 24, 1844. In addition to the re-enactment of that event, the centennial will be celebrated by the unveiling of a memorial plaque by a joint Congressional committee. The telegraph companies participating in the ceremony will be the Western Union Telegraph Company, the International Telephone and Telegraph Corporation, Radio Corporation of America Communications, Inc., and the American Telephone and Telegraph Company.

A commemorative symposium on the Morse telegraph is being planned for the AIEE summer meeting in St. Louis, Mo., June 26–30, 1944.

Powerful Projector Contacts Cloud Ceiling

Westinghouse photo

This 16-inch searchlight and alidade, an instrument which sights the projector's beam, are placed 1,000 feet apart on the roofs of aircraft hangars to determine the altitude of the cloud ceiling. The searchlight's beam, which can reach five miles high, in striking the lowest layer of clouds forms a round bright spot about the size of a dinner plate. This spot is sighted through the telescope-like tube of the alidade and focused in the center of a mirror at its base. The tube swings across a semicircular strip of steel marked off for hundreds and thousands of feet. When the tube is focused, a marker at one end indicates the altitude of the clouds.

OTHER SOCIETIES •

Wickenden's "The Second Mile" Republished by ECPD

A new version of "The Second Mile," an address delivered before the Engineering Institute of Canada in February 1941 by William E. Wickenden (F '39) AIEE vice-president and president of the Case School of

Applied Science, Cleveland, Ohio, has been reissued by The Engineers' Council for Professional Development under the title, "The Second Mile—A Resurvey, 1944." Essential substance of the original address appeared in *Electrical Engineering*, May 1942, pages 242–7.

The revised pamphlet is slanted toward presenting the engineering profession to the young engineer. To this end the text was shortened, the style modified, and a new section, "Does an Engineer Need His Profession?" was added. Copies of the revised reprint can be obtained at 10 cents per single pamphlet, five cents per pamphlet in small lots, and $3 per hundred, from the ECPD, 29 West 39th St., New York 18, N. Y.

Future Meetings of Other Societies

American Society of Mechanical Engineers. Semiannual meeting, June 19–20, 1944, Pittsburgh, Pa.

American Society of Refrigerating Engineers. 31st spring meeting, June 5–7, 1944, Pittsburgh, Pa.

Canadian Electrical Association. Annual meeting, June 22–23, 1944, Murray Bay, Que.

Edison Electric Institute. Annual conference, June 6–7, 1944, New York, N. Y.

Radio Manufacturers Association, 20th annual convention, June 6–7, 1944, Chicago, Ill.

Society for the Promotion of Engineering Education. Annual meeting, June 25–28, 1944, Cincinnati, Ohio.

IRE Publishes Facsimile Standards. Results of study by the 1942 and 1943 committee on facsimile of the Institute of Radio Engineers recently have been published as "Standards on Facsimile: Temporary Test Standards." The standards were compiled to satisfy urgent demands from IRE members, the Armed Forces, and the radio industry as a whole, ensuing from their respective war requirements. The standards cover fundamentals of facsimile, apparatus performance, and transmission. Experience in applying the standards and subsequent review by facsimile technical committees will make possible their future publication in more complete and carefully considered form. The standards may be procured from the IRE, 330 West 42nd Street, New York 18, N. Y., at 20 cents per copy.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

A Letter on the Kilgore Bill

This letter from an AIEE member to H. M. Kilgore, United States Senator, supplements Doctor Bush's letter published in the February 1944 issue of "Electrical Engineering," pages 57–62.

Dear Senator Kilgore:

Since I received the testimony on the science mobilization bill, S 702, which you sent me, I have given much study to the subject and, as a result, I send you herewith my conclusions.

Considerations of the bill may be divided into three parts:

1. General political implications.
2. The fostering of science in educational institutions.
3. Scientific developments in relation to industry.

GENERAL POLITICAL IMPLICATIONS

There seem to be two fairly well-defined schools of thought the one advocating a strong paternalistic Federal Government probably based on the ideas of efficiency and the general welfare, and the other advocating the rights of the individual in a free democracy.

Possibly those who belong, more or less consciously, to the first school at the same time consider themselves allied to the second. The president of a weak college, seeing an opportunity to secure Federal aid, might favor the bill although he would at the same time assert his devotion to the ideals of democracy and the freedom of the individual.

There can be no doubt that Americans in overwhelming majority wish to preserve our Government in its traditional form and oppose the tendency, toward an all-powerful state. This bill, then, should be written so as in no way to infringe on the freedom of the people. Some of your own comment indicates that you may believe the bill as drafted is satisfactory in this regard and, if so, you will not be averse to having it tested by competent and unprejudiced persons. For my part, I believe it has grave faults in that it gives the administrator powers of coercion which should rest with Congress.

Another political implication is bound up with the organization as planned. The plan is that most groups should be represented in shaping the policy of the Office of Science Mobilization regardless of their qualifications, experience, or interest in, scientific research and development.

To obtain this general representation the Office includes, besides the all-powerful administrator, a board, and a committee. The board of seven, including the administrator, contains only two members who are scientists or technologists, the other four representing different sections of American life. The six members are entirely subservient to the administrator with the exceptions that "they shall have access to all information of the Office relating to the administration thereof," and the board must approve compensation, determined by the administrator, to persons as a reward for inventions or discoveries deemed by the administrator to be in the national interest and when they are vested in the Office.

The committee consists of the board, single representatives of Federal departments, four additional representatives of the consuming public, making five in all, six additional representatives of labor, making seven in all, six additional representatives of management (including small business), making seven in all. The committee thus consists of 24, plus as many Federal department representatives as the President shall choose to appoint, of whom only five need be scientists or technologists. The function of the committee is to advise and consult with the administrator upon basic policies of administration of the act, and it shall meet not less than once a month.

This organization seems to be set up to provide a predominating influence of interests which are far removed from any knowledge of the aims and objects and requirements of scientific work.

In my opinion the board and committee should consist overwhelmingly of scientists and technologists, and the administrator himself should be one or the other. The committee, moreover, being advisory need not meet more than twice a year, at which times it can hear reports and go thoroughly into questions of policy and procedure. It then becomes a real advisory committee with reference to basic policies rather than a committee which would find itself dipping into details and grinding political axes.

Another political aspect of the bill is its substitution of control by the administrator for control by law. Many Americans are convinced that Congress has gone too far in vesting legal powers in the hands of bureaus under the President. This bill appears to go even further in that direction. Among the objectives of the bill are matters which should be controlled by law, for example: "the trend toward monopolized control of scientific and technical data and other resources," and not be put into the hands of an administrator with power.

There are many matters relating to patents, monopolies, and industrial practices which the office could place before Congress with recommendations for suitable laws to improve existing practices. This aspect would seem to be provided for in "Purpose of the Act, 9" which is "to provide guidance . . . . to the President, the Congress" whereas the act gives such sweeping powers to the administrator that instead of providing guidance he can resort to dictation.

I sincerely hope that your committee will give especial consideration to the wording of the act so that it shall not grant arbitrary powers to the administrator or to the Office, and again, I hope that the personnel will be changed so that the great majority will be scientists and technologists and that thereby the office shall be prevented from becoming a bone of contention between rival interests.

THE FOSTERING OF SCIENCE IN EDUCATIONAL INSTITUTIONS

I now come to that aspect of the bill which relates to the fostering of science in educational institutions. We have so many educational institutions now, including numerous lamentably weak ones, that it would seem generally undesirable to create new ones.

Because of the heavy taxation of wealth coming years, it would seem desirable that financial aid be supplied to educational institutions which heretofore have depended on private support. Education should be available to all to pursue as far as individual ability justifies. But it is recognized that many youths are encouraged beyond their abilities, and this may be attributed to the sometimes desperate need of the colleges for funds which these students provide.

By improving the economic status of educational institutions a measurable increase in employment would be achieved, not only by increase in the number of institutional employes but also by the virtual employment of increased numbers of students

In many ways our educational institutions could be improved greatly to the advantage of science and the general welfare. However, the method of bringing this about implied in the wording of the bill is by no means satisfactory. There is too much danger of loss of freedom both by the institution and by the individual.

For science to flourish, freedom of thought and action are essential. Whatever may be said in favor of science under autocracy wherever regimentation enters, science suffers.

The first three paragraphs of the bill's declaration of policy give a very erroneous impression of the state of science in this country. Especially during the last forty years has it advanced phenomenally. The bill implies that vastly greater progress would be possible under the fostering care and authority of the Office of Science Mobilization presided over principally by nonscientists. The evidence in support of this view is certainly not impressive.

What might be done is to give added stimulation and support in the training of men for science and in the research conducted by institutions. But in giving this stimulation and support it would be far wiser if the Government agency would work in cooperation with the State governments, both lending financial support in accordance with general rules of procedure carefully drawn to avoid infringement of essential freedom necessary to the best accomplishment in scientific work. All this should be thought out carefully by men of broad vision and experience in scientific matters. The bill as drawn appears not to have come out of such a background. Such men as J. B. Conant, K. T. Compton, R. A. Millikan, and others that could be named are conspicuous by their absence from the hearings and correspondence and there is no evidence that they had any part in drawing up the bill.

SCIENTIFIC DEVELOPMENTS IN RELATION TO INDUSTRY

We now come to the third part—scientific developments in relation to industry. A very large part of the testimony is directed to this phase of the subject. Unfortunately it is, I should say, the least impressive part of the testimony, and gives the least genuine support to the bill. Judge Arnold's contribution is an obviously prejudiced attack on what he designates as cartels and in making the attack he casts great discredit on our industrial leaders as though they were the force of unrighteousness like a leech sapping the vitality of an otherwise righteous people. Judge Arnold may believe this to be true but against it there is strong evidence which your committee seems inclined to discount or avoid. The remedy for any evils due to cartels should rest with Congress, which, at the same time could pass laws freeing silver to the American people and putting a quietus on such restraining activities as those of James Caesar Petrillo.

Judge Arnold also attacks the practice in the use of patents. I am sure patent laws could be and should be improved, but the general subject of industrial development of new products and their exploitation seems too great for Judge Arnold to grasp. In general it may be said that new products are brought out as fast as practically possible. It costs money not to bring them out, but it also takes time to commercialize an invention. If brought out too soon there is loss due to servicing, replacement, and alterations; if too late there is development expense without a return. This is the condition which pertains especially to the small company.

Present practice in patent law does give an advantage to the large company, but this could be remedied. The main consideration of patents is to decide what is invention and what are its limitations and then to establish the limitations so all can understand what they are. This should be done by Congress and not by an administrator of the Office of Science Mobilization.

We must now consider some aspects of the conduct of scientific research by industry. In the testimony there is repeated reference to the advantages of the large company over the small company in ability to afford research. This alleged advantage is not strictly true. It is the large company which finally has discovered that research pays, that it pays even though the immediate objective is not apparent. It is the large company which can afford long time and costly experimentation, but this is in line with a costly product. It is in the nature of the case that a small company could not engage in the manufacture of large turbogenerators. The large company is essential in American industry. But the large company also makes a great variety of products to which research is applicable, whereas the small company has a more limited product and therefore can get along with much less research. Lack of research by small companies is not due to inability to afford it but is due rather to lack of conviction of the value of benefits to be gained. Many small companies are directed by self-taught business men, often men of real ability, whose attention is demanded by many diverse phases of the business. Research to them is often just an item of expense, a luxury which eventually might or might not bring a return. Research to them often means getting answers to questions of the moment; a project which must wait six months or a year for fruition, might be grasped, but one which extends over two or three years would be hard to comprehend as a practical investment.

As the smaller companies come to understand what research can do for them they will not be kept from going into it. They would understand more readily if they were not so primarily sales-minded. The fact that small companies increasingly are going in for research indicates a growing understanding of its desirability.

CONCLUSION

It thus appears that the functions of the Office of Science Mobilization as outlined in the bill have been extended to and beyond the danger point. The bill as drawn creates a supercontrol of scientific and technical facilities which amounts to autocratic control of all property, programs, projects, processes, procedures, patents, and so forth, used or intended to be used in research, development, and production of goods or services. Any act so comprehensive involves a threat to the existing order of American life. If it is desirable at all—of which there is certainly a reasonable doubt—it should be studied by the best and most experienced minds and subjected to intense scrutiny from every angle.

Mention has been made of Presidents Conant and Compton and Professor Millikan in connection with the bill's impact on educational institutions. Such men as F. B. Jewett, W. R. Whitney, and Charles F. Kettering should certainly be consulted with reference to industrial research. The testimony already taken is extremely unconvincing. Some of it comes from men who seem to have given the actual bill scant attention; some comes from professors who appear to be interested mostly in the possibility of securing financial assistance; some comes from persons who obviously are unqualified to express an intelligent opinion. These generally favor the bill.

You, Mr. Senator, in a letter to A. R. Ellis, president, American Council of Commercial Laboratories, state that Henry Kaiser, William M. Jeffers, Donald Nelson, and the late Edsel Ford have approved the bill. The testimony which you sent me contains no letter from any of these men except Mr. Ford, and his letter, as I read it, hardly could be regarded as an endorsement.

I, therefore, beg leave to conclude by expressing the hope that you and your committee will give weight to the objections I have pointed out and will seek further counsel from those men who really are qualified to voice opinions on so important a measure. I thank you for giving me the opportunity of again expressing my views.

WALTER L. UPSON (M '20)

(Director of research, Torrington Manufacturing Company, Torrington, Conn.)

Cultural Training of the Engineer

To the Editor:

Mr. Boyajian's paper, "Cultural Training of an Engineer" in the January 1944 issue (Transactions section, pages 6–8) of *Electrical Engineering* has stirred a number of reactions in me which I shall attempt to record. I, too, speak as a parent (one 12-year-old son), and also as adviser to students in the earlier terms of the engineering course of study at Columbia University. My own training in educational methods and in psychology is limited, and limitations of time prevent the preparation of a commentary supported by references, figures, and so forth. Therefore these are my unstudied reactions to the paper.

First, I would state that Mr. Boyajian does well to address himself to parents, for they, jointly with the grade and secondary

schools, provide the influences which, in my opinion, shape young people. His suggestions on habit formation and the various "cultural" matters which he enumerates (*a–g*) should be the concern of every parent and school teacher. For it is my belief that by the time a boy enters college at 17 years of age he is well nigh "set" in his lifetime patterns. Clearly there has been a long 16 years of influence operating in a boy during his most plastic years. I believe many educators, Mr. Boyajian included, depend too much upon forces brought into action during the college years. But the torrent already is rushing tumultuously seaward—college provides a number of alternate channels.

His advice to parents, therefore, might include the strong injunction that the boy have freedom to seek his proper channel during those early college terms. Over 80 per cent of the boys who come to Columbia University are emotionally "set" for one career or another (each the result of dozens of different influences). Provision must be made for them to adjust and to discover more of their capacities and inclinations. At Columbia University this results in some 50 per cent of those initially called engineers redirecting their efforts and plans toward law, business, medicine, and in fact toward every sphere of study.

From the above one would gather that I consider Mr. Boyajian's statement of cultural or educational training too narrow. That is the case. But it may be noted that I believe the prescription should be written for life and not for the college years alone. I am not sufficiently wise to write a prescription for life, though in a fashion I am helping to administer some sort of mixture to our young son.

I cannot resist, however, making specific comments on Mr. Boyajian's own prescription, though I offer no proposals of my own.

Improper Study Habits. Most of the college students who come to Columbia University have had an easy time in high school and have not had to study outside of classes. Contrarily educational progress in college must be made via self-directed study, the classroom serving less for drill and more for inspiration. As to the physical conditions of study (radio on, desk, references, and so forth), these characteristics are acquired long prior to the college period.

Habits of Speech, Grammar, Social Character. These are well formed on entrance to college. Interesting measurements of speech characteristics have been made at Columbia (and at many other colleges). These and grammar are very definitely formed out of the influences of family and precollege schooling. The force and proper use of language for written and oral conveyance of thought are, I believe, related to subjects for thought or speech, mechanical skill in writing, vocabulary, and the aggressive characteristic of the individual. These develop through the whole youth of the child and little can be added in the college years, compared with the earlier increments.

Johnson O'Connor, who developed the human measurements laboratory at Stevens Institute of Technology, believes vocabulary is a very important factor in life. He notes the correlation between vocabulary and the outstanding success of leaders who often have had little "formal" training. Mr. Boyajian's statement, ". . . the knowledge of English—vocabulary and grammar—of the average freshman is fully adequate for his needs" relates to the above, as follows. I believe O'Connor has found little change in vocabulary as a result of college training. Therefore one must be ready to admit that a student will be limited in his understanding, conceptions, and in his statements within his vocabulary. The situation is analogous to an engineer's use of mathematical symbolism. Mr. Boyajian, himself, must be intimately familiar with dependence upon the language and vocabulary of mathematics for the work in electric-circuit analysis.

In conclusion, I would state that leadership, success, or whatever end results, comes not from a few college terms of application in a particular way to a few particular subjects, but is rather the product of a long series of influences and experiences, which begin at birth, continue through college years, and through all the years that follow.

A. D. HINCKLEY (M '38)

(Assistant to the dean of faculty of engineering and instructor in electrical engineering, Columbia University, New York, N. Y.)

To the Editor:

Engineers have tried for years to compress the educational curricula leading to technical degrees into as small a space of time as possible. The catalogues of engineering schools always have been replete with advanced courses in such subjects as turbine design and armature-winding techniques, the ultimate usefulness of which to the student is open to serious question. Because the bill of fare is so filled with these courses, there is no time, we are told, to add culture. So we turn out engineers indifferently grounded in fundamentals; filled with specialized and highly technical knowledge in a specific field, in which the whole practice may change before they have worked two years; and utterly unequipped to live in the world of varied interests which surrounds them.

Now comes Mr. Boyajian's paper entitled, "Cultural Training of the Engineer," (AIEE *Transactions, volume 63, January 1944, pages 6–8*) in which he advocates for "cultural" training just three simple instructions: the development of ability to study efficiently, to deal with others successfully, and to express oneself well. That, for the engineer, is to be culture.

No one can argue with the need which he envisions for the student to acquire these three skills. Such requirements are so obvious as to need no elaboration. In fact the first and third elements should be well mastered by the end of a first year in college. The second is more difficult and is one in which many engineers are woefully deficient. One may question whether a course in "practical psychology" of the Dale Carnegie type will do the job. Usually, the ability to get along with one's fellows is developed more by doing it than by reading about it.

Webster's dictionary defines culture as the "act of developing by education, discipline, training, etc., . . . the enlightenment and refinement of taste acquired by intellectual and aesthetic training." The three suggestions for minimum "cultural" instruction made by Mr. Boyajian go a little way along the route of the first definition; but they wholly miss the second.

The compressed "cultural" curriculum which is advocated in the paper suggests a number of important questions:

1. Is this curriculum just intended for use during wartime?

2. If not, why is there so much emphasis on the lack of time in the program for culture?

3. Are engineers to be educated solely for the engineering job they intend to do, rather than as broad and complete citizens of their country and the world?

4. How will engineers with such limited educational advantages grow up to their responsibilities in the social system with personal and cultural backgrounds which enable them to take their places among the practitioners of other independent professions?

It is suggested that engineers would be better fitted for their jobs, for life and its enjoyment, and to become members of a really independent profession, if the following changes in the educational system could be instituted:

1. Concentrate the technical portion of the curriculum on mastery of fundamentals as distinct from specialized courses, the subject matter of which, in these fast-changing times, may be obsolete before the student graduates.

2. Allow time in the first years of the curriculum for really cultural subjects and encourage the embryo engineers to dip into literature, art, languages, philosophy, economics, or any of the other myriad subjects which make a complete individual.

3. Extend the time needed for an engineering degree from four years to six or seven, if need be, to accomplish this. Some engineering schools have already done this; other professions such as medicine and law have required it for a long time, with important beneficial results to their members.

EDWIN FLEISCHMANN (M '29)

(Engineer, Washington, D. C.)

Horsepower Meter for Aircraft

To the Editor:

Despite all the propaganda of our air-minded friends who seek to avoid the inhibitions and traditions which exist in other elements (sea and land), I note that J. C. Luttrell and W. A. Petrasek speak of "The Horsepower Meter for Aircraft," in their article in *Electrical Engineering*, November 1943, page 501.

Why not use the term "wattmeter"? Are they so hidebound by tradition in this infant industry that they still think of horses to drag their planes around? Or did aviation start with Pegasus in the time of the Greeks?

PAUL MacGAHAN (F '42)

(Development engineer, Westinghouse Electric and Manufacturing Company, Newark, N. J.)

TVA Releases Annual Report

In the letter from C. M. Jansky (F '32) which appeared in the April issue of *Electrical Engineering*, page 159, the statement, "For example the private utilities of Wisconsin paid 46 cents per kilowatt hour in taxes. . .," should read: "0.46 cents per kilowatt hour."

e following new books are among those recently eived from the publishers. Books designated ESL available at the Engineering Societies Library; se and thousands of other technical books may borrowed from the library by mail by AIEE mbers. The Institute assumes no responsibility statements made in the following summaries, ormation for which is taken from the prefaces of books. All inquiries relating to the purchase of book reviewed in these columns should be dressed to the publisher of the book in question.

ble of the Bessel Functions $J_0(z)$ and z) for Complex Arguments. Prepared the Mathematical Tables Project, Work ojects Administration of the Federal Works ency, conducted under the Sponsorship the National Bureau of Standards. Pubhed by Columbia University Press, New rk 27, N. Y., 1943. 403 pages, illustrated, by 8 inches, cloth, $5. (ESL.)

Bessel functions of orders zero and one are countered in the general solution of boundy-value problems in the theory of potential, at conduction, and wave motion, when the main is bounded by a circular cylinder. particular, they occur in the problem of e propagation of electromagnetic waves th a straight wire as a guide, the theory of e skin effect for poorly conducting wires, e problem of oscillatory motion of a sphere a viscous medium, the vibration of a heavy ain in a resisting medium, and other undary-value problems. These tables are lculated to ten decimal places and a bliography is provided.

ubrication of Industrial and Marine achinery. By W. G. Forbes. John iley and Sons, New York, N. Y.; Chapman d Hall, London, England, 1943. 319 ges, illustrated, $8^1/_2$ by $5^1/_2$ inches, cloth, 3.50. (ESL.)

This manual discusses the everyday probms that arise in lubricating engines and achines of various types, and offers pracal solutions. Starting with a description the fundamentals of distillation, cracking, fining, and so forth, the author proceeds discuss the effects of heat, pressure, and etals on lubricating oils and the methods applying lubricants. Later chapters deal ith the lubrication of steam engines, hyaulic turbines, pneumatic tools, internalmbustion engines, machine tools, steel d paper mills, and wire ropes. Heateating oils and greases are discussed.

ime Bases. By O. S. Puckle, with a foreord by E. B. Moullin. John Wiley and ons, New York, N. Y.; Chapman and Hall, ondon, England, 1943. 204 pages, illusated, $8^1/_2$ by $5^1/_2$ inches, cloth, $2.75. SL.)

This book, based on a paper presented efore the Institution of Electrical Engineers 1942, is intended to cover the more imortant electronic devices available for proucing the time axis in television receivers, athode-ray oscillographs, engine indicators, d similar apparatus involving precise ming or measurement of time intervals. aims to provide an introduction to the inciples, and to deal with the construction, sting, and uses of these devices. Apendixes discuss the cathode-ray tube and e effects of time constants and other valve d circuit parameters.

Latin America. Americana Corporation, New York, N. Y., and Chicago, Ill., 1943. 126 pages, illustrated, $8^1/_2$ by 11 inches, cloth binding $2.50, cardboard, $2.

Based on the latest edition of the Encyclopedia Americana, this reference book presents a fundamental background of place names, products, movements, political and cultural leaders, events, objets d'art, and dates for anyone wishing to become thoroughly familiar with Latin American life. The Latin American countries are treated as a unit in arranging the important information about their geography, industry, agriculture, art, literature, politics, music, history, and international political and economic relations. Separate summaries of basic conditions in each of the Central American republics are also given. The volume is amply illustrated.

Table of Circular and Hyperbolic Tangents and Cotangents for Radian Arguments. Prepared by the Mathematical Tables Project, Work Projects Administration of the Federal Works Agency, conducted under the Sponsorship of the National Bureau of Standards; published by Columbia University Press, New York, N. Y., 1943. 410 pages, tables, 11 by 8 inches, cloth, $5. (ESL.)

This volume, which is a companion volume to the "Tables of Circular and Hyperbolic Sines and Cosines," published in 1939, gives circular and hyperbolic tangents and cotangents for radian arguments from 0 to 2 at intervals of 0.0001 and from 0 to 10 at intervals of 0.1. The tables are given to eight significant figures. There is a good bibliography.

Principles and Applications of Electrochemistry. Volume 2. Applications. By W. A. Koehler, Second edition. John Wiley and Sons, New York, N. Y.; Chapman and Hall, London, England, 1944. 573 pages, illustrated, $8^1/_2$ by $5^1/_2$ inches, cloth, $5. (ESL.)

Intended both as a textbook for students and as a reference work for the man in electrochemical industry, this book covers primary and secondary cells, electroplating, electrometallurgy, electrolysis, electric furnaces, and various special applications. New topics added in this edition include continuous tin strip plating, magnesium from sea water, fluorescent lamps, induction heating, and several new types of furnaces and storage batteries.

Thermodynamics. By J. E. Emswiler. Revised by F. L. Schwartz. Fifth edition. McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1943. 335 pages, illustrated, $8^1/_2$ by 5 inches, cloth, $3. (ESL.)

The important practical topics covered are steam power, vapor refrigeration, and airheat engines. The theoretical treatment of energy, the laws of thermodynamics, permanent gases, mixtures, and the flow of fluids are kept to basic considerations, with the whole forming an introduction to the more abstract phases of the subject. New material on absorption refrigeration, gas turbines, gas cycles, adiabatic saturation, and supersaturation has been added in this edition.

Design of Machine Members. By A. Vallance and V. L. Doughtie. Second edition McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1943. 559 pages, illustrated, $8^1/_2$ by $5^1/_4$ inches, cloth, $4. (ESL.)

This text has been prepared for the use of students who have had some training in kinematics, mechanics, and factory processes. Upon this foundation the author develops the theory involved in the design of the elements of operating machines and points out the variations from theory required by practical applications. Considerable space has been devoted to engineering materials, factors of safety, utilization factors, and the selection of design stresses. Illustrative review problems are provided for each chapter.

Time Study Engineering. By W. H. Schutt. McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1943. 426 pages, illustrated, 9 by 6 inches, cloth, $5. (ESL.)

Every detailed phase of time study is covered on the basis of specific machine studies and in a simplified form understandable by those unfamiliar with shop production methods. Shop production methods, machinery, and tools are completely explained as well as the step-by-step study that should be made of particular operations. New simplified explanations of speeds and feeds and detailed analysis for determining "line tasks" and controlling man power are given.

Beloved Scientist. By D. O. Woodbury, with a foreword by O. D. Young. McGraw-Hill Book Company, Inc. (Whittlesey House Division), New York, N. Y., 1944, 358 pages, illustrated, $9^1/_2$ by 6 inches, cloth, $3.50. (ESL.)

In this biography the versatility of Elihu Thomson is demonstrated effectively. As a pure scientist and as a practical engineer, his talents were directed along many lines, although his most noteworthy achievements were in the field of electricity. As business man, teacher, or administrator, he was in the front rank. The author has developed a history of the electrical industry and built it around the figure of Elihu Thomson and his brilliant contemporaries.

Complex Variable and Operational Calculus with Technical Applications. By N. W. McLachlan. The Macmillan Company, New York, N. Y.; The University Press, Cambridge, England, 1942. 355 pages, illustrated, $8^1/_2$ by $5^1/_2$ inches, cloth, $4.75. (ESL.)

A modern treatment of the operational method is offered in this book, with illustrations of its application to problems in radio, television, heat transmission, electrical circuits, and other technological subjects. The operational procedure advocated is believed to offer advantages in speed and ease over other methods. The book is intended primarily for engineers who use mathematics in solving technical problems.

Elementary Statistical Methods. By H. M. Walker. Henry Holt and Company, New York, N. Y., 1943. 368 pages, illustrated, $9^1/_2$ by 6 inches, linen, $2.75. (ESL.)

This textbook is based on courses given

in Teachers College, Columbia University. The author has aimed at a clear simple exposition that will make the text practically self-teaching and has given particular attention to the development of underlying concepts and to interpretation. Emphasis is placed upon statistical techniques, with the treatment including the limitations and advantages of each, the assumptions underlying it, and the interpretations which can be made from it. Some chapters have bibliographies.

Applied Safety Engineering. By H. H. Berman and H. W. McCrone. McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1943. 189 pages, illustrated, $8^1/_2$ by $5^1/_2$ inches, cloth, $2. (ESL.)

This textbook places emphasis on the practical use of safety engineering rather than on methods and the reasons for them. After presenting the fundamental requirements for a safety program, the book describes how investigations should be made; how to write safety rules, regulations, and messages; how to hold safety conferences; and how to make talks and inspections. Each topic is illustrated by cases and specimens.

Manual of Firemanship. Issued under the authority of the Home Office (Fire Service Department) and published by His Majesty's Stationery Office, London, England, 1943. 119 pages, illustrated, $8^1/_2$ by $5^1/_2$ inches, paper, 2s.6d. Obtainable from British Information Services, 30 Rockefeller Plaza, New York, N. Y., 75 cents. (ESL.)

This is the third part of a "survey of the science of firefighting" prepared for the men and women serving in the National Fire Service of Great Britain, as a guide to modern principles and to the equipment available. This part deals with water supplies of all kinds: hydrants, fire mains, emergency and mobile supplies, piping, and water relaying.

Quantum Chemistry. By H. Eyring, J. Walter, and G. E. Kimball. John Wiley and Sons, New York, N. Y.; Chapman and Hall, London, England, 1944. 394 pages, illustrated, $8^1/_2$ by $5^1/_2$ inches, cloth, $5. (ESL.)

This book contains a systematic presentation of quantum mechanics from the viewpoint of its usefulness in developing the concepts of chemistry and physics. It provides an introductory treatment of reaction rates, optical activity, molecular structure, spectroscopy, and group theory. It has been written at the level of the graduate student in chemistry, and assumes a knowledge of calculus on the part of the reader.

Technique of Radio Design. By E. E. Zepler. John Wiley and Sons, New York, N. Y.; Chapman and Hall, London, England, 1943. 312 pages, illustrated, $8^1/_2$ by $5^1/_2$ inches, cloth, $3.50. (ESL.)

This volume by an experienced radio designer deals with problems that are linked closely with the daily routine work of an engineer in the development and testing of radio-receiving apparatus of all types. Such questions as the transfer of energy from the aerial, detection and frequency changing, selectivity, receiver noise, screening, undesired feedback, and distortion are treated rather comprehensively with attention to intimate details.

Table of Reciprocals of the Integers From 100,000 Through 200,009. Prepared by the Mathematical Tables Project, Work Projects Administration of the Federal Works Agency, conducted under the sponsorship of the National Bureau of Standards. Published by Columbia University Press, New York 27, N. Y., 1943. 201 pages, tables, 11 by 8 inches, cloth, $4. (ESL.)

This table expands tenfold the scope of existing tables in this interval, in which interpolation between tabular entries is somewhat difficult because of the large differences between the successive intervals in the existing tables of Oakes and Cotsworth.

Analytical and Applied Mechanics. By G. R. Clements and L. T. Wilson. Second edition. McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1943. 475 pages, illustrated, $8^1/_2$ by $5^1/_4$ inches, cloth, $3.75. (ESL.)

The mathematical and physical theory necessary for a thorough first course in mechanics is presented for use as a college text. A great many problems are included to demonstrate both obvious applications and logical extensions of the theory. This edition has been revised on a basis of actual classroom experience with the earlier edition and contains many new problems.

Medical Radiographic Technic. Prepared by the technical service department, General Electric X-Ray Corporation under the editorial supervision of G. W. Files. Published by Charles C. Thomas, Springfield, Ill., and Baltimore, Md., 1943. 365 pages, illustrated, $10^1/_2$ by 7 inches, fabrikoid, $6. (ESL.)

This manual of the fundamental principles and practical methods of medical radiography is designed for X-ray operators. The book is illustrated by a wealth of photographs and detailed instructions for taking all the radiographs in general use. The book should be very useful to any operator.

Statistical Adjustment of Data. By W. E. Deming. John Wiley and Sons, New York, N. Y.; Chapman and Hall, London, England, 1943. 261 pages, illustrated, $8^1/_2$ by $5^1/_2$ inches, cloth, $3.50. (ESL.)

This is a practical reference and textbook on the adjustment of data, with emphasis on scattered portions of the subject that are difficult to find elsewhere and that, in the author's opinion, are becoming increasingly important. Different kinds of problems of adjustment are unified and brought under one general principle and solution. Statistical procedures for curve fitting and other adjustments by least squares are discussed.

Car Builders' Cyclopedia of American Practice. 16th edition, 1943. Compiled and edited for the Association of American Railroads, mechanical division; edited by R. V. Wright, R. C. Augur, and others Simmons-Boardman Publishing Corporation, New York, N. Y., 1943. 1324 pages, illustrated, 12 by $8^1/_2$ inches, fabrikoid, $5. (ESL.)

The new edition of this well-known reference book follows the style of its predecessor, with some improvements in form and with better indexes. It again brings up to date the record of American car designs and car equipment.

Technology and Livelihood. By M. L. Fleddérus and M. van Kleeck. Russell Sage Foundation, New York, N. Y., 1944. 237 pages, illustrated, 9 by 6 inches, paper, $1.25. (ESL.)

Prepared for the Russell Sage Foundation, this report is a study of the effect of recent changes in the productive capacity of our basic industries upon opportunities for employment and upon living standards. Information accessible in government publications has been assembled and summarized so as to be understood by those without experience in production or training in technology.

Radio Receiver Design. Part I. By K. R. Sturley. John Wiley and Sons, New York, N. Y.; Chapman and Hall, London, England, 1943. 435 pages, illustrated, $8^1/_2$ by $5^1/_2$ inches, cloth, $4.50. (ESL.)

This book presents the fundamentals of receiver design by a detailed stage-by-stage examination of the receiver, starting from the aerial. The present volume, the first of two, ends at the detector stage. Each chapter has a bibliography.

PAMPHLETS • • • •

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

Selection of Supervisors. By Harold W. Dornsife. California Institute of Technology, Pasadena 4, Calif.

Will You Help? Engineers Council for Professional Development, 33 West 39th Street, New York 18, N. Y., 8 pages. no charge.

Power Centers. Westinghouse Electric and Manufacturing Company, Sharon, Pa., 25 pages.

Metermax Combustion Control for Boiler Furnaces. Leeds and Northrup Company, 4907 Stenton Avenue, Philadelphia, Pa., 36 pages.

Price List of American Standards. American Standards Association, 29 West 39th Street, New York 18, N. Y., 23 pages.

How Accountancy and Engineering Share in Effective Tool Control. 6 pages. **How Business Engineering Benefits Business.** 8 pages. **How Waste Reduction Boosts Production.** 12 pages. George S. May Business Foundation, 111 South Dearborn Street, Chicago 3, Ill.

Magnetron Oscillator for Instruction and Research in Microwave Techniques. By J. Tykocinski Tykociner and Louis R. Bloom. University of Illinois, Urbana, 30 pages, 40 cents.